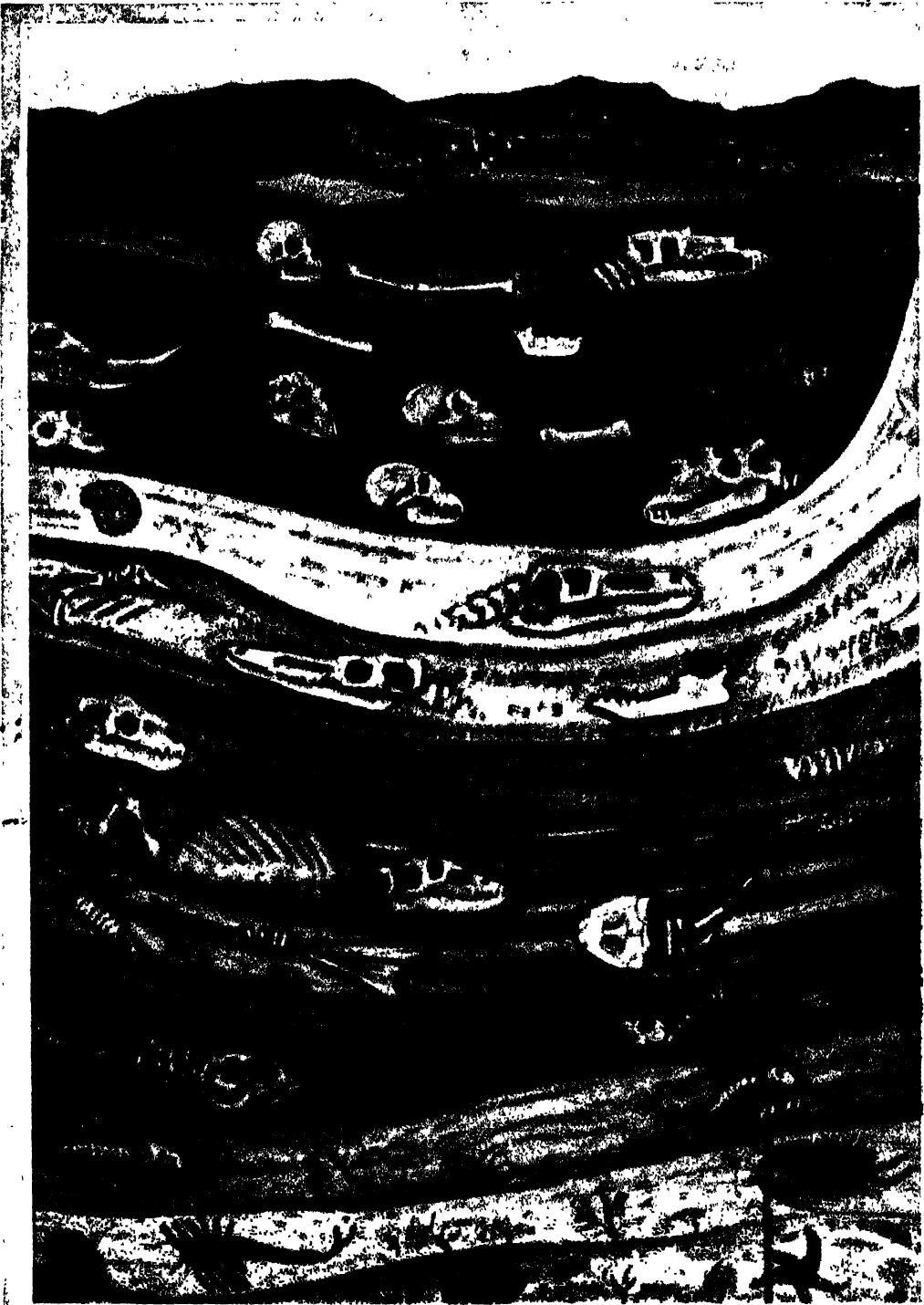


## THE RECORD OF THE ROCKS



*If you study this page you will see how life has developed on earth. The first five layers are Paleozoic,*

*the next three are Mesozoic, and the last four belong to the Cenozoic Age, which includes the present day.*



# Richards Topical Encyclopedia

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VOLUME THREE



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*(For specific facts relating to this subject consult the Index)*

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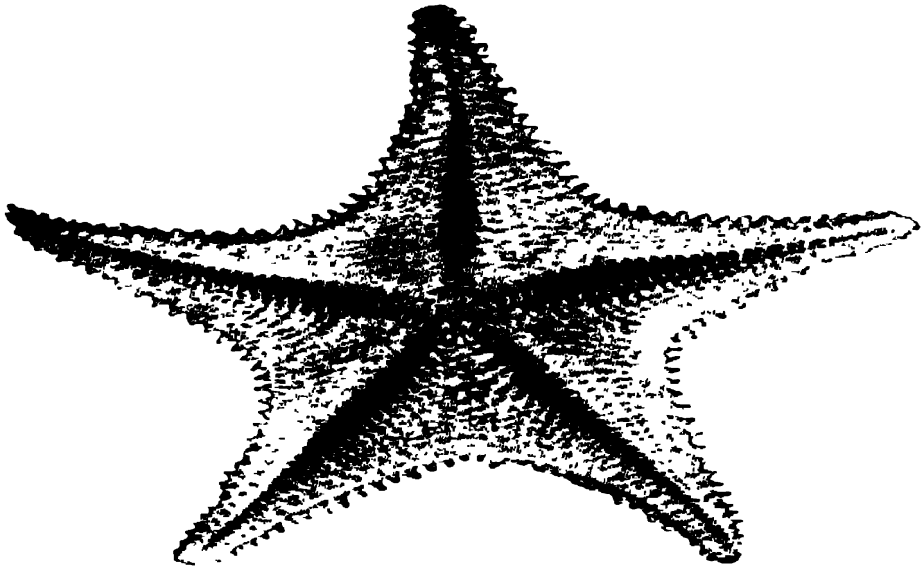
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## KEY TO PRONUNCIATION

ā, as in māte	oi, as in toil
á, as in senāte	oo, as in soon
â, as in hâir	ôó, as in bôók
ǎ, as in hǎt	ou, as in shout
à, as in fāther	s, as in so
ä, a sound between ä and ǎ, as in càstle	sh, as in ship
ch, as in chest	th, as in thumb
ē, as in ēve	th, as in thus
ê, as in rêlate	û, as in cûre
ĉ, as in bĕnd	û, as in accûrate
ê, as in readĕr	û, as in fûr
g, as in go	ŭ, as in ŭs
ī, as in bīte	ü, a sound formed by pronouncing ē with the lips in the position for oo, as in the German <i>über</i> and the French <i>une</i>
ĭ, as in ĭnn	zh, as in azure
k, as in key	’, an indication that a vowel sound occurs, but that it is elided and cannot be identified, as in apple (ăp’l)
K, the guttural sound of ch, as in the German <i>ach</i> , or the Scotch <i>loch</i>	A heavy accent (ˈ) follows a syllable receiving the principal stress, and a lighter accent (ˊ) follows a syllable receiving a secondary stress.
n, as in not	
N, the French nasal sound, as in <i>bon</i>	
ng, the English nasal sound, as in strong	
ō, as in bōne	
ô, as in Chrîstôpher	
ô, as in lôrd	
ô, as in hôt	

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# *The RECORD of the ROCKS*

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## Reading Unit No. 1

### THE RECORD OF THE ROCKS

*Note: For basic information not found on this page, consult the general Index, Vol. 13.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Kinds of rock formations, 3-1-2  
How we learn about the past from the present, 3-3  
How sedimentary rocks are formed, 3-3-4

How plants and animals are preserved forever, 3-5-6  
How we divide the world's history into eras, 3-6  
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#### *Things to Think About*

How do we know what living things were once present on the earth?  
Why are no fossils found in igneous rock?  
How is sedimentary rock formed

to-day?  
How are fossils made in nature?  
What kind of living things appeared first?  
Why are earlier plant and animal remains so hard to find?

#### *Picture Hunt*

What happened to some of the sedimentary rock on top of this hill? 3-1  
How do you explain the presence of fish fossils on mountain tops far away from water? 3-3  
Why were many mammoths

found whole in Siberia? 3-4  
Why are fossil tree trunks very stony? 3-5  
In which layers of rock are human fossils found? Color plate, Frontispiece, Volume 3

#### *Leisure-time Activities*

PROJECT NO. 1: To learn how fossil molds are made, mix some plaster of Paris and pour it over a clam. After it hardens, split the plaster and look carefully at the mold, 3-5.

PROJECT NO. 2: Inquire at your local museum for places suitable for fossil hunting. Conduct your own expedition for fossils.

#### *Summary Statement*

The surface of the earth is constantly changing. Rock particles are washed away and carried by water to the sea, where they are put down in layers. After countless centuries these

layers become rock and may be raised out of the sea. Often they contain remains of plants and animals that died and were preserved in the original mud.



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## THE RECORD OF THE ROCKS

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Photo by U. S. Geological Survey

The record of the rocks must be pieced together from pages of Nature's book that are scattered all over the world, for in no place do we find more than a small chapter set down in order in the rock layers. Above, you may see a few pages of our book. Great earth movement bent the rock layers into a hill. Then a stream cut down through the hill, exposing the layers to view. The pages that come before lie hidden beneath the stream, deep down in the earth. The

pages that come after have been washed away. And so, to complete the chapter, we shall have to search somewhere else to find our missing pages exposed to view. Sometimes Nature leaves out a few chapters, but even though they are missing in one place, we can always find them in another. It is often very hard to fit together chapters that are found in different parts of the world many miles away from each other; so it will be a long time before our story can be complete.

## *The RECORD of the ROCKS*

### *This Will Tell You of the Strange Way in Which Mother Earth Wrote Her Autobiography, and of the Trouble We Have in Reading Parts of It*

**N**O MATTER how many ages ago it was—whether millions or billions of years—when the very first forms of life began to appear on this old earth of ours, the same unbroken laws of nature were in command as are in command to-day. The more closely we try to read those great stone pages of the record of the rocks, the more we are awed by the orderly march of events and the steady progress of plant and animal life throughout the ages. Epoch has followed epoch with steady tramp, each leaving its

record of life graven on the pages of the great stone book that lies open all around us. For it is in the rocks of which our Mother Earth is made that we must trace her history and the history of all the forms of life around us.

But we must always remember that it is a very, very long and ancient record which we are trying to make out, and we must not feel surprised or disheartened when we find that some of its earlier pages have become more or less torn, misplaced, or blotted out.

## THE RECORD OF THE ROCKS

Our progress has to be slow and difficult. But when we try, however dimly, to realize the immense passage of time that these records of the rocks represent, we can only marvel that they are as complete as we find them.

Now we have likened the record of the rocks to the pages of a book simply because, for the most part, each layer of rock, no matter how ancient or how recent, was laid down under water as a flat, smooth sheet of material. The sheet nearly always contained some fossils (fös'ıl)—remains of plants or animals—which serve as illustrations to that particular page of the earth's history. The rocks that do not show these traits had a different origin, since, as we shall see, they were once molten.

You may often clearly see these layers of the rocks—beds or "strata" (strā'tā), they are called by geologists—as you stand looking at the face of some great cliff on the seashore or the mountain side. They show, too, in a stone quarry or a deep railway cutting. One of the most wonderful places in the world to see such layers piled one on top of another is from the top of the Grand Canyon of the Colorado. But we cannot all go there, and even in that mighty gorge not all the layers are exposed; so the face of a cliff or a quarry will help us nearly as well to understand how the layers rest.

### The Rumbled Pages of Our Record

You will see, first, that the layers are of different colors and different thicknesses, and that in many places they no longer lie flat like the leaves of a book as it rests on a table, but have got bent into curves and arches, folded over one another, and even tilted right up on end, almost to a vertical position.

Since they were once smoothly spread out beneath the sea, they must have been later squeezed and folded and then lifted up to the height of the quarry where we now find them. But if we visit a quarry where an igneous rock, like granite, is being worked, we shall at once notice that the face of the

quarry has a different appearance. Although the granite may have short cracks running through it, there are no regular beds or layers, for the granite was forced up from below as one large, red-hot, molten mass.

We can see how certain kinds of igneous rocks are formed even to-day if we visit a region where volcanoes are active. The molten material that pours out and flows down the sides of the active volcano is known as lava (lä'vā). Lava is in certain ways different from granite because the lava has come to the surface, whereas the granite has cooled at some depth within the earth. When the lava is thus cooled suddenly, all the things which make it up freeze in particles so small that we cannot see them with the naked eye. But a granite, being covered over with a blanket of other rocks,

cools slowly, and its materials have time to move around and rearrange themselves. They gather into little patches which are often large enough to be visible. Some patches may be pink, others black; many have a glassy look. And these facts may be true even if the lava is made of exactly the same things as is the granite. It is simply that each kind of matter in the granite has had time to collect in spots large enough to be seen; as the geologists would say, the granite is coarse-grained and the lava fine-grained.

If we look carefully at the face of a cliff or cutting where both kinds of rock are exposed to view, we shall see that the igneous



Photo by New York Botanical Garden

Along the seashore to-day or along the sandy bottom of a little stream you may often find a series of tiny parallel ridges and valleys. We call them "ripple marks"; they are made by the movement of the water as it passes over the sand. We find such ripple marks in ancient rocks, such as the one above. Often they are now far from any water—sometimes they are in a desert—but they tell us that this dry region was once covered with water.

## THE RECORD OF THE ROCKS

rock always occurs in irregular masses without beds or layers, and no matter how carefully we search, we shall never find traces of animals or plants in these rocks that have come up from so far below. But the sedimentary (séd'i-mén'tā-ri) rocks are in regular layers or strata, and the fossils in them tell us that their place of formation was in the sea.

It is with the sedimentary rocks that we are most concerned, because they alone contain the materials which make it possible for us to piece together something of the past history of plant and animal life.

Right down through the ages the same natural forces that are at work to-day have built up the layers of these fossil-containing rocks, partly from the wreckage of the older rocks, partly from the remains of plant and animal life in each age.

### How a Stream Makes a Great Canyon

It is only recently that we have realized that the natural forces which do these wonders are the same to-day as in the far past. On the flat plain of northern Germany are scattered here and there huge boulders which we know must have had their origin far to the north. The early scientists believed that these boulders must have been carried to their present position by some tremendous flood—that there are no forces in existence to-day which could carry such large rocks. Other scientists were impressed by certain very deep and large canyons in which flowed rather small streams. "Surely," they said, "that little stream could never have cut the great gorge in which it now flows. Some huge upheaval must have made this valley and then the stream discovered it and chose to flow there." But we no longer believe in past miracles. We have found that ice sheets can move great blocks of stone, and

that it was ice sheets that carried those boulders to Germany. Also, we know to-day that almost all streams have cut the valleys in which they now flow. To be sure, a little stream cannot cut a large valley very rapidly; but if given sufficient time it can do all that work just by carrying away a few grains of rock each day.

Through millions of years it has been able to cut a great gash in the crust of the earth.

So we are brought to believe that "the present is the key to the past." And this is the only "theory" which we could use; for if we suppose that there were miracles and great floods and

"catastrophes" in past times we must give up our hopes of ever understanding those times. We must take for granted that the laws of nature have not changed since the beginning of time—which means that the same sorts of forces are now active on the surface of the earth as have been active all during the history of our planet.

Thus we can see sedimentary rocks forming to-day; there is nothing miraculous about the process, except as all the wonderful doings of nature may seem miraculous. In the spring of the year we may see how the streams from the hills come rushing down all swollen and muddy; for the heavy rains and melting snows have washed from the face of the mountain bits of weathered and crumbling rocks and earth, material which will be carried down by the swift streams to help form new mud banks where the river widens out to meet the sea. Many creatures, shells, insects, and the stems and leaves of plants caught by the swirling tide, will also be carried along and buried in the deepening mud, at last to form new fossil records of our own day. But all these patient processes by which the mountains are worn down and carried bit by bit to the sea are described on other pages of these books.

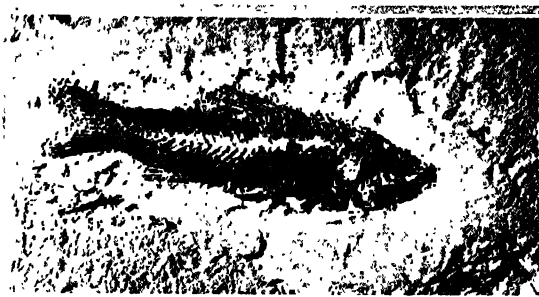


Photo by American Museum of Natural History

This little fish lived more than 100,000,000 years ago. He swam in the Cretaceous seas. When he died his body fell to the bottom and was covered over with sediments. These sediments have been turned into rock and are now high up on Mt. Lebanon in the dry country of Syria.

## THE RECORD OF THE ROCKS

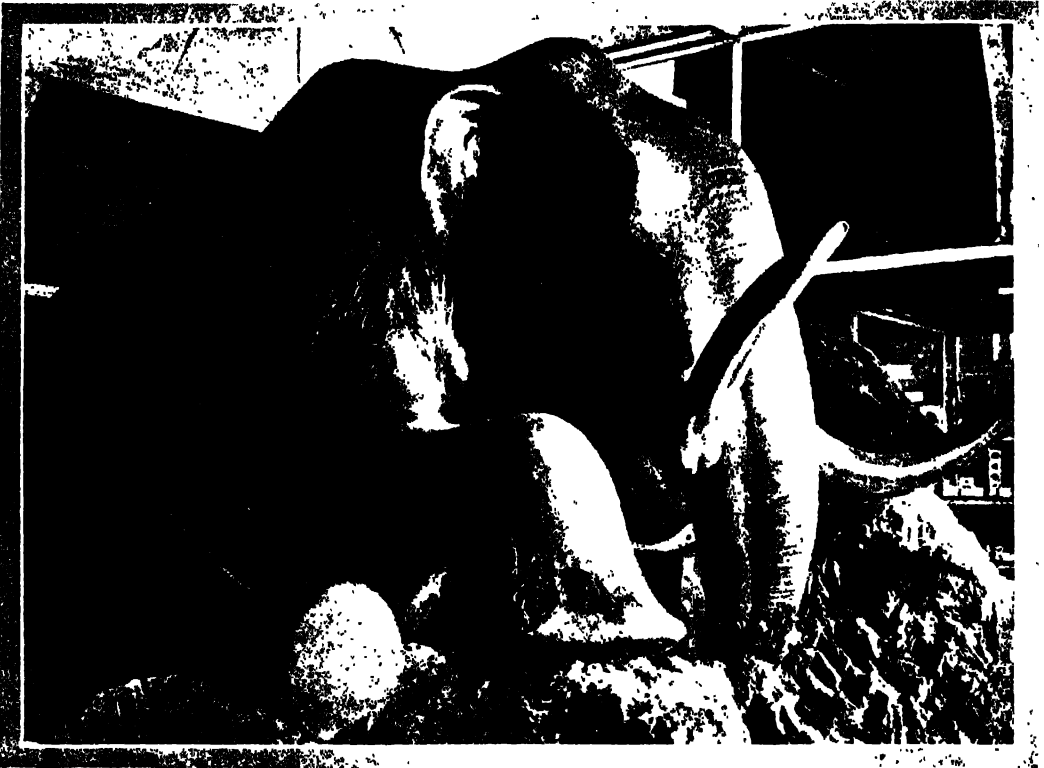


Photo by James's Press Agency

Most of our fossils tell us about nothing but the hard parts of animals—the bones, shells, and so on. We know practically nothing about their soft parts—the skin and hair, for example. We do not always know whether the animal was fat or thin; if, for instance, we had not seen a camel, we could never tell from its skeleton that it had a hump. All of this leads to one of the most thrilling discoveries in modern times, the finding of hairy mammoths, such as the one above, buried in the icy soil of Siberia. The earth had acted

as a giant refrigerator, preserving the hair, skin, and eyes, and all the internal organs absolutely intact. In one case the scientists were able to find out from the contents of the beast's stomach exactly what it had eaten before it died. They even found out what it had died of—a broken blood vessel! For several hundreds of years Siberia exported tons of elephant tusks a year, but no one quite knew where they came from. The diggers themselves thought the beasts were giant moles who died when exposed to light.

For at last the sea does receive much of this matter carried down by the rivers. Its shores are bordered by gravel beaches, sand banks, and mud flats, the haunt of sea birds and beasts whose skeletons are covered by the deepening sand and mud. And the sea itself is always wearing away the base of the cliffs. During the winter storms the huge waves act like battering rams on the face of the rocks, shattering them to pieces and dislodging great masses that come tumbling down into the waves. The ceaseless action of the waves rolls the fragments over and over until they are ground, first into smooth pebbles, and at last into fine particles of sand which are swept along the coast by currents. Sometimes the sand is carried out to sea, there to be piled up in sand banks which

some day may be converted into new beds of sandstone.

Just as we watched the rivers in the spring bringing down the debris from the hills and valleys, so every autumn we may see how new soil is being made through the gradual decay of what we call "organic remains." Then the red and golden-yellow leaves fall from the trees and make a ruddy carpet in the woods. The rains beat down upon them, and later the snow hides them. At last they and all the grasses and tangled growth of summer decay and are crumbled away, adding yet another very thin layer of black earth to the soil in which the great old oaks and beech trees stand firmly rooted. Thus each year a little additional layer of vegetable matter is formed in exactly the same way

## THE RECORD OF THE ROCKS

and by exactly the same natural forces as were formed the layers which finally turned to coal in the days of the long-gone Carboniferous (kär'bön-îf'ēr-ūs) Age, or Age of Coal.

• Before we start hunting for any fossil remains entombed in the different layers of rock, it will be just as well if we try to understand how they became fossils.

Now there are three principal ways by which the remains of plants and animals are turned into fossils. In the first of these, some or all of the actual material making up the body of the animal or plant is preserved. It is only very rarely that we find the flesh of ancient animals, but it has happened. The bodies of elephants which lived long ago in Siberia have been dug up from the frozen soil; the flesh was so perfectly preserved by the cold that it was fed to the dogs of the expedition which made the discovery. But much more often only the hard parts of the animal or plant are left for our study. We find the bones of many animals, the teeth of fish, reptiles, and other creatures, and the shells of many forms like clams and oysters. In some geologic strata which may be several million years old, the shells of clamlike animals are so well preserved that if they were found on the beach they would not be taken for fossils at all.

In the next type the fossil is really a cast or mould of the original object. What has happened in this case we can understand if we think of what might take place if an oyster, a clam, a snail, or any other shell had been embedded in soft mud or clay. If the mud were sufficiently soft and fluid, as the upper surface of a mud bank is when covered

by the tide, the first thing to happen would be that the semi-fluid mud would enter and settle in the shell, until at last it completely filled the inside. Meanwhile the surrounding mud would make a thick coat on the outside of the shell. As ages went by this mud bank with its contents would be turned into rather soft stone. And to-day if

we break into the stone with a hammer and chisel, we shall find that it contains a perfect mould of the outside of the shell, and another of the inside. It is not a very difficult matter to make similar moulds for ourselves by embedding shells or other objects in plaster of Paris. If the mass is allowed to harden, it may then be carefully split open and the moulds of the shell laid bare.

If the rock is porous and will absorb water, we may find that the original shell has been entirely dissolved away, leaving the inner mould loose within the mould of the outside of the shell. In some cases, the space once occupied by the shell itself has been filled up by some foreign mineral matter deposited there by the water that has seeped in. Then we have a hard object which has the exact shape of the original shell. That is to say, we have a mineral cast made from the original mud-mould of the

shell. Artists make casts in this way to-day.

When fossils are made according to the third method—which is the most perfect and complete one—we find that they reproduce, with the greatest accuracy, not only the external form, but even the most minute internal cell structure of the original object. Such fossils have been formed by a chemical process which replaces every particle of the original organic matter of the object by some



Photo by U. S. Forest Service

Trees as well as animals have been turned to fossils. Sometimes they sink below the water and are found with animals of the sea. But the tree trunks above were not fossilized in this way. The forest in which they stood was smothered under a blanket of volcanic ash. Later hot waters trickling through the ash carried away the woody material, replacing it, molecule for molecule, with the silica they carried in solution. And so the trunk you see here is really stone; but if you were to polish a piece of it, you would be able to see the tree's growth rings and all the tiny cells which made up the fiber of the trunk. These fine details are very clear, so clear that it is actually easier to study the structure of fossil woods than it is to study a living tree!

## THE RECORD OF THE ROCKS

mineral substance, such as calcium carbonate (kāl'sī-ūm kār'bōn-āt) or silica (sīl'i-kā). Some of the most beautiful examples of this wonderful process are to be met with in specimens of fossil wood, which show not only the external grooves and markings of the bark, but, in cross section, the rings of yearly growth, and even the tiniest cells and microscopic marking on the walls of the tissues. We can see just as many details as we can in a freshly gathered stem. Fossil plants in beds of coal are made almost entirely of carbon, and have all their tiniest structures beautifully preserved in this manner; and in amber, which is really a fossil resin, we even find numbers of insects and spiders perfectly preserved.

On another page you will find a table which shows the different layers of the rocks, or strata, arranged in their proper order, with the name by which each important layer is known. The oldest, or first-formed rocks, are at the bottom, and the latest at the top; and each layer represents a chapter in the history of the earth. Geologists divide this long history into five great ages, or eras (ē rā). You will not find the names hard, once you understand them. The first is named the Archeozoic (är'kē-ō-zō'ik), the era of "Ancient Life," or simply Archean (är-kē'ān), or "Ancient" era, since we have no definite proof that life existed at that time. This era includes the oldest known rocks. The second great era is called the Proterozoic (prōt'ēr-ō-zō'ik), or "Earlier Life." The third is the Paleozoic (pāl'ē-ō-zō'ik), or time of "Old Life." The last two are the Mesozoic (mēs'ō-zō'ik), or era of "Middle Life," and the Cenozoic (sēn'ō-zō'ik), or time of "Recent Life." The Cenozoic includes the more recently formed strata, and the plant and animal life of the present day. It must be borne in mind, however, that this table by no means represents all the chapters in the great stone book of the past history of the earth, but only those that have so far been discovered and deciphered. From top to bottom there are here and there pages that are missing, where the record has been effaced; and although new discoveries are

constantly being made, it appears doubtful in many cases whether the complete record can ever be pieced together.

Exactly how or when the first forms of life appeared on this earth we can never know, for the oldest rocks of which there is any trace are almost always changed and, have more or less lost their original texture. And besides, they are so poorly exposed for observation, so folded, bent, and broken, that any fossils they might have included have long ago been totally destroyed. They are all so much alike in different parts of the world that only with the greatest difficulty can any idea be gained of the order in which they were formed. Nevertheless, direct evidence has been found in some of these earliest rocks to prove that microscopic forms of plant life were in existence in that far-off day. Indeed, we know that plants must have come before animals in time, for the animal world, both on land and in the sea, is entirely dependent upon plants, and cannot exist without them.

The first simple one-celled microscopic plants lived in the shallow waters just as their descendants do to-day. This was for the very good reason that in the water the organic salts they must have, are to be found in the form most suitable for their needs. So from what we know of the nature of plants, of their food and habits, we may feel confident that we are very near the truth in assuming that the first forms of life to appear were very simple microscopic plants that lived in the seas and lakes of those far-off days. And more than that, the animal remains found in the earliest fossil-bearing rocks are all forms of water life. So all the existing evidence is in favor of the theory that both plant and animal life began in the sea. It is in the earliest of the slates and sandstones—sedimentary rocks formed when the very first of all rocks were broken down and deposited in the ancient sea—that we have found faint traces referred to as possible worm tracks and the tracks of early shell-clad animals called crustaceans (krūs-tā'shān). But of those ancient animals themselves we have no remains at all.

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# *The RECORD of the ROCKS*

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## Reading Unit No. 2

### WHEN LIFE DAWNED IN THE SEAS

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The age of the earth, 3-8  
When life first began on the earth, 3-9  
The kind of animals that lived

during the Cambrian Period, 3-9-10  
What the world looked like in the Cambrian times, 3-10

#### *Things to Think About*

How old is the earth, according to modern scientists?  
How long has it taken small streams to lay down thousands of feet of sedimentary rock?  
Why are there no fossils in Archean rocks?  
When did animals first appear, judging from the fossils we have found?  
Why are there so few fossils found in Proterozoic rocks?  
In what rocks did enormous num-

bers of fossils first appear?  
In what kinds of surroundings did animals and plants first live?  
What kinds of animals lived in Cambrian times?  
What do fossils teach us about the trilobites?  
What Cambrian animals still live to-day?  
What kind of plants lived during the Cambrian period?  
Why were there no animal sounds during the Cambrian period?

#### *Picture Hunt*

How are many fossils destroyed?  
3-10

Why do rock layers seem wavy?  
3-10

#### *Summary Statement*

The formation of rocks from mud brought to the oceans by sluggish streams is a very slow process. To-day, after studying many rock layers, scientists agree that the age of the earth is between one and two billion years. The earliest forms of life either left no fossils, or, if they did, their

fossils were destroyed in the rocks. In the Cambrian rocks many fossils of simple animals are found. None had a backbone. All lived in water. Typical of the animals was the trilobite, which later died out, though the horseshoe crab still survives to-day.

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## THE RECORD OF THE ROCKS

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Most of the pages of our Book of the Rocks are no longer in neat, orderly piles. Movements of the earth's crust have bent and buckled them so that

many of them look like the waves of the ocean. This sometimes has a sad effect on the fossils, which may be squeezed out of shape or entirely destroyed.

### WHEN LIFE DAWNED *in the* SEAS

*What You Would Have Seen and Heard if You Could Have Taken a Walk along the Seashore in What We Call the Cambrian Age, Millions of Years Ago.*

**G**EOLOGISTS are always talking about geological periods and telling us that these periods are immensely long. But how long? That is a question the wisest geologist cannot answer exactly. Earlier geologists made widely varied estimates of the age of the earth, from a few thousand to many thousand years—but for a long time they always guessed in thousands. Then some venturesome souls suggested that it might have taken *millions* of years for our earth to reach its present condition; they were laughed to scorn. Even fairly recently we were told by one excellent authority that the world could not be more than fifty million years old.

But to-day most geologists agree rather well on the ages they find for the various periods in the history of the earth. And

they no longer count in thousands—not always even in mere millions. The oldest rocks we know of, they tell us, are about one and one half or two billions of years old! The earth itself, of course, is much older than that, but we cannot get down into the depth of it to study the even older rocks which are probably there. So geologic history is vastly longer than any of our ancestors thought. Indeed, it is so long that we cannot even imagine the length of it. Only when we learn of the many events that have slowly come to pass in this history—of the many mountain ranges which have been folded up and then worn down to flat, featureless plains, of the vast and incredible changes in living things—do we begin to understand the meaning of a million or a billion years.

Our table of the geologic ages shows us a



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## THE RECORD OF THE ROCKS

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number of "periods" of time. From the time of our oldest rocks to the present, we have, as we have said, some two billion years to divide up among the periods. Though we do not know just how this time is to be divided, we can be sure of one thing: that for each period we may have as much time as we need. If we see that during the Cambrian period, which began some 500 million years ago, there were great changes in life and in the relations of land and sea—changes which must have taken vast lengths of time in the making—then we can be sure that enough time is available. Geologic time is so long that we have plenty of it to account for the enormous work done by small streams, plenty of it to explain the striking advances made by animals and plants—and plenty left over for good measure.

### When Did Life First Begin?

We must turn back over a large part of this long geologic time to see the beginnings of life on the earth. We shall probably never know just when and how life first appeared. But it must have been deep, deep in the hidden past, long before the first fossil traces of it can be found. Many millions of years have passed over the Archean (är-kē'än) rocks, crushing and crumbling them and often changing their very substance by chemical action. How do we know what countless generations of simple living organisms may have lived and died in that far time, leaving no trace which has not been entirely rubbed out by the years? Even the earliest fossil remains which we take for those of something once alive may perhaps not indicate life at all—they are so scant and faint that we cannot be sure.

Yet we know that some time in the Archean or early Proterozoic (pröt'ër-ô-zô'ik) life must have appeared, because we find a few remnants, or fossils, in the later Proterozoic rocks. Then when we turn to the lowest rocks of the next great geologic era we come suddenly upon enormous numbers of fossils. These Cambrian rocks—so called because they were first studied in Wales, whose name in Latin is 'Cambria"—are the lowest, oldest layers in the Paleozoic (pā'lë-ô-zô'ik), or Era of Ancient Life. It is not

the varied, highly-organized life we know to-day on land and sea; but it is far from being the simplest life of mere one-celled organisms, like amoebas or bacteria, either. Not only complicated plants but animals have appeared, and the Cambrian seas swarmed with living things.

### When All Animals Lived in the Waters

For as yet all the animals lived in the water. And even there we should find no fishes, no animals of any kind that have backbones—only smaller backboneless creatures, invertebrates (in-vûr'tê-brât), as the zoölogists call them. Many of them do not seem to have changed much in all the ages since that time, and their descendants live to-day much the same simple, efficient, unthinking life that they did so many billions of generations ago.

So if we could visit those strange seas, we should see sponges growing on the rocks, and certain sorts of coral, though not the kind which were later to build the great coral reefs. Barnacles incrusting the rocks, and the ancestral forms of water fleas, shrimps, and prawns dwelt in the tidal pools. There too were the ancestors of both starfishes and their graceful cousins the crinoids (kri'noid), or "sea lilies." Resting on the sea floor or wandering over the rocks or swimming through the waves were many forms of shell life, or Mollusca (mô-lûs'kâ), in the language of the scientist—primitive oysters, mussels, sea snails, and the ancestors of the nautilus and the cuttlefish. Marine worms crawled about on the floor of the sea and burrowed in the sand and mud, just as they do to-day.

### The Flourishing Days of the Lamp Shells

Among the most flourishing animals of the Cambrian seas were the brachiopods (bräk'i-ô-pôd'), or lamp shells. These creatures are well named, for the soft parts of their bodies are inclosed in a two-valved shell shaped rather like an old Greek or Roman oil lamp. In Cambrian days there were a great many brachiopods and they were widely scattered through the waters. They became more and more numerous and flourishing, until in the Devonian (dê-vô'nî-än) period they reached their highest point of development. In the

## THE RECORD OF THE ROCKS

rocks of that time we find an immense number of species of them. But after that they gradually fell off until now there are only about a hundred species in all the seas of the world. Two kinds of brachiopods seem to have changed scarcely at all since Cambrian times. That this could happen helps us understand how simple a form of life they are, since highly organized animals always change and develop more quickly.

### The Curious Trilobites

But the dominant, or most important, form of life in the Cambrian seas was the trilobites (trī'lō-bīt). These were curious creatures with oval or oblong bodies made up of a series of segments, or sections; each segment was divided into three parts, a central one and two outer ones, so that the animal as a whole was three-lobed, as its name indicates. Most of the body segments carried on the under surface two pairs of jointed legs, one pair for walking and one pair, more paddle-like, for swimming; but none of the legs ended in claws like those of crabs or lobsters. Many kinds of these strange creatures had large, complex eyes. Trilobites varied greatly in length, from a bare half inch to more than two feet. Like their kindred, the crabs and lobsters of to-day, the trilobites laid eggs, and as they grew they cast off their shelly armor from time to time.

These extraordinary animals must have literally swarmed in the seas of Cambrian and Silurian (sī-lū'rī-ăn) times, to judge from the number of fossils of them we find. And they must have lived in almost all the seas of the world, for we have found their fossils in the Cambrian rocks of countries as far apart as Great Britain and South America, Newfoundland and Australia. Later they very gradually fell off in numbers, until before the close of the Paleozoic era they had died out altogether. The record of the rocks tells many such tales of species of living things that have risen and then died away.

Another interesting sort of crustaceans

(krūs-tā'shăn)—that is, creatures with crust-like shells—which lived in Cambrian times, were the Merostomata (měr'ô-stô'mâ-tâ), of which only the horseshoe or king crab has survived to our day. The Eurypterida (ū'rīp-tēr'ī-dâ), another kind of Merostomata, were queer, scorpionlike things which dwelt in the Cambrian seas. They started as small, slender animals with bodies about six or eight inches long, but kept growing larger and larger as the generations passed, until they had become huge nightmare creatures measuring all of nine feet. Finally, in the Carboniferous (kär'bôn-īf'ēr-ūs), or coal-forming, period, they died out, or, as we say, became extinct.

Of Cambrian plant life we know very little indeed. Only a few fossils (fôs'ıl) of sea weeds have been found, and no land plants at all, though it is quite possible that some simple forms of plants were already growing on the land.

### The Strange Cambrian Landscape

And what would that land have looked like in those far times had there been anyone there to see? And what was the appearance of the sea? So far as we can tell, the sea would have looked much the same as it does to-day, though the forms of life in its depth were different. There are some lands to-day, too, which still look much as all the land must have looked then—desolate plains, great mountains, here and there a smoking volcano—with strong rivers swirling along, laden with sediment to be deposited upon their mud flats as they widen to meet the sea. There were no trees anywhere, and of course no birds or insects or mammals.

And over all there must have been a strange silence—no voice of bird or beast, no hum of insects. All the earth was wrapped in a vast, deathlike stillness broken only by the boom of the surf on the shore, the sighing of the wind, the roll of thunder among the hills, or now and again the roar and hiss of some volcanic eruption.

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# *The RECORD of the ROCKS*

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## Reading Unit No. 3

### WHEN NATURE BEGAN TO MAKE BACKBONES

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How backboneed animals began to appear on the earth, 3-12  
The decline of the trilobites, 3-13  
Why diatom fossils are abundant, 3-14  
The origin of the famous French

and English chalk cliffs, 3-14  
The rise of the mollusks, 3-15  
The first creature with a backbone, 3-15  
North America was once under an ocean, 3-15

#### *Things to Think About*

Why are plant fossils usually very rare?  
Why were diatoms well preserved through the ages?  
When did mollusks first appear on the earth?  
What was the probable ancestor

of our backboneed animals?  
What do the rocks teach us about the geography of our country in ancient times?  
How do we know that the Arctic regions were once very warm?

#### *Picture Hunt*

What is the composition of most of the coast of England? 3-12  
Where does rock go when it is broken by the waves? 3-12

How is our coast line sculptured? 3-12  
What animals did early fishes resemble? 3-14

#### *Related Material*

In what important explosive are fossil diatoms used? 2-69

How do diatoms keep all animals in the ocean alive? 2-69

#### *Leisure-time Activities*

PROJECT NO. 1: Make a study of fossil diatoms by examining

various scouring powders with a microscope, 2-68

#### *Summary Statement*

During Ordovician times there was a great surge of sea life, which included diatoms, trilobites, sponges, graptolites, mollusks, and starfishes. Later a fishlike

animal arose which developed something like a backbone. During this period the climate the world over, even in the Arctic, was tropical.

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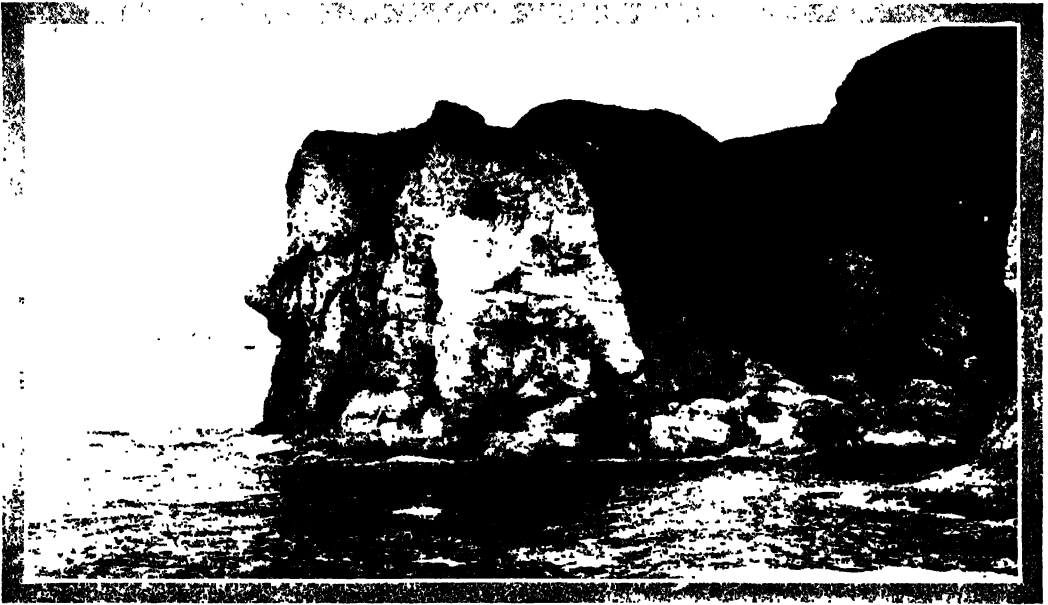


Photo by L. M. & S. Railway

This great cliff on the coast of England is called "Giant's Head" because the waves have carved it into the likeness of a huge face. Many fine cliffs

along England's coasts have been cut out of the soft limestone that millions of years ago was nothing but the shells of billions of tiny sea creatures.

### WHEN NATURE BEGAN *to* MAKE BACKBONES

*This Will Tell You What Was Going on in the World in That Far-off Age When Nature Had Not Even Learned to Make a Real Fish*

**W**E ARE so used to the world as it is that we never stop to realize that it is always changing—that it has been, and will be, a very different place from the earth we know to-day. The future, of course, is a closed book. But thanks to the hard work of an army of learned men, we have been able to puzzle out a good deal about the past.

Here we shall tell you what they have made out of the record written in the rocks that saw the beginnings of creatures with backbones—higher forms of life than the shell-clad creatures of earlier times. The record is in the layers of rock which come next above the Cambrian layers, about which we have told on earlier pages. These later layers of rock were formed during what geologists call the Ordovician (ôr'dô-vîsh'ân) period; the name comes from an ancient

British tribe, the Ordovices (ôr-dôv'i-sēz), who at the time of the Roman conquest lived in that part of Wales where these rocks are fully exposed. But in North America too there are wide areas of Ordovician rocks, and in them we have many traces of the plant and animal life that lived in the Ordovician seas.

So far geologists have found no evidence in Ordovician rocks of any creature that lived on land. But on the other hand, wherever there has been a particularly good chance for fossils to be formed, the record tells clearly of an amazing number and variety of creatures in the seas. There are still no real vertebrates, or animals with backbones; but geologists trace their beginnings in the fossil remains of certain fishlike creatures called ostracoderms (ôs'trăk'ô-dĕrm). We shall hear more about the ostracoderms by and by.

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But this was, above all, the age during which all the great types of backboneless animals of the sea developed and thrived. We can trace through the different layers of this immensely long period the story of the rise, progress, and decline of many species of them, and sometimes their final extinction, or dying out.

One type of sea life especially important in this period was made up of a multitude of small, branching creatures not unlike the feathery "sea firs" that today live in the rock pools and attached to the dark brown ribbon seaweeds. These plantlike animals were very numerous and widespread; their fossil remains have been found in the Ordovician rocks of Europe, North and South America, Australia, and other parts of the world. They were first described by the great naturalist Linnaeus (lĭ-nē'ŭs), who called them graptolites (grăp'tô-lĭt), from the Greek, "grapho"—"I write"—and "lithos"—"stone." This was because some of them look like written or penciled marks on stone; others are not unlike little quill pens.

### The Queer Shape of the Graptolites

A graptolite colony was made up of a series of little horny cups attached one below another to a common stem, in either a single or a double row. When the colony was alive each cup contained a single little tentacle-crowned animal, or polyp (pôl'ĭp), as it is called. Some of the more complex forms consisted of from two to eight single unbranched stems growing out from a common center, each stem carrying its fringe of tiny cups. These colonies of graptolites seem to have lived in the surface waters of the sea,

where they were carried along by ocean currents and blown by the winds far and wide; and they were probably the ancestors of the graceful, feathery, horny-textured sea-fir polyps that grow abundantly as fixed colonies on the rocks and weeds in the deep tidal pools along rocky coasts to-day. From the point of view of the geologist, who thinks in terms of millions of years, the graptolites

were a short-lived race. Their first fossil remains are found in scanty numbers in rocks of late Cambrian days; they flourished and increased enormously throughout the long range of time covered by the Ordovician period, but dwindled and died out in Devonian (dē-vô'nĭ-ăn) times.

There were other groups of backboneless sea creatures who reached their development and then began to decline during Ordovician times.

Among them were the graceful feather starfishes called cystoideans (sis-toi'dē-ăn), and certain great ten-foot-long, straight-shelled cousins of our modern cuttlefish. These species were never again to be so varied in form and size, or so abundant as they were throughout the Ordovician period.

It was also in the Ordovician seas that those strange forms of crust-covered creatures, the trilobites (tri'lô-bit), of which we told in the story of the Cambrian rocks, reached their highest development and began their long, slow decline. From the multitude of fossil forms that we have found in the Ordovician rock layers, it is clear that the trilobites must then have swarmed in vast numbers. They were a little different from their Cambrian ancestors—their tail shields were much larger, they could roll themselves

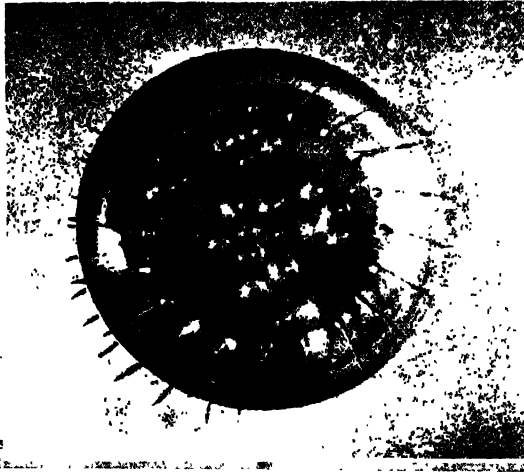


Photo by American Museum of Natural History

This is a picture of a diatom, a tiny plant of the sea, here shown greatly enlarged. Most diatoms are so tiny that you would have to pile several hundred of them together to make a spot that you could see. Yet there are beds a thousand feet thick formed entirely of their fragile little skeletons.

## THE RECORD OF THE ROCKS

up like tiny armadillos, and they had eyes that were better developed.

So far as we can discover from the record of the rocks, plant life did not advance much in this time. For we have found no fossil remains of plants which we can be quite sure are any higher in the scale than seaweeds, and we have found no sure sign of any land plants. But we must always remember that plants do not have hard bones or shells like animals, and so are much more likely to perish without leaving any fossil remains behind them. Therefore in all layers of rock the record speaks more clearly of animal than of plant life, and this is particularly true of the layers of which we are speaking now — those that tell of early epochs of the world's history, when most plants had simple, soft tissue that perished very easily indeed.

But while the more highly organized plants seem to have died and rotted away long before they could become fossils, many species of microscopic, one-celled water plants called diatoms (dī'ā-tōm) have left abundant evidences of their presence in the seas of the long ago. This is because they formed a wonderful flinty skeleton of silica, and this skeleton has survived. In the same way many fossils of certain one-celled forms of animal life—the Foraminifera (fō-rām'i-nīf'ēr-ā), with their limy skeletons, and the radiolarians (rā'dī-ō-lā'ri-ān), with their exquisite radiating skeletons of silica—have come down to us. These tiny one-celled winners in life's race developed the habit of forming skeletons of lime and silica—or flint—and have hardly changed at all in size or shape during the millions of years that have passed since Ordovician days. Their descendants still swarm in the seas of the present time. From the bottom of the Atlantic men have drawn up a grayish mud, or "ooze," which is composed almost entirely

of the round skeletons of certain of these one-celled organisms. While they are alive these tiny living things swarm in the surface waters, but when they die, their skeletons sink to the floor of the sea. There they slowly accumulate in a bed that grows thicker and thicker—until some day it may rise above the surface as the white chalk cliffs of a new land. The famous chalk cliffs of Southern England and Northern France were formed in this way.

So far as we can tell from their flinty skeletons, certain forms of sponges prospered and increased in numbers during Ordovician times. Other kinds of sponges probably flourished then, too. But just as with plants, it is the animals with hard skeletons that leave fossils, so the sponges we know about are those which had built up skeletons of small, sharp pieces of lime or flint.

The great order of sea creatures to which the starfishes and the prickly sea urchins belong was increasing in numbers and variety all through the Ordovician period. While fresh forms were appearing, others which were prosperous enough in the Cambrian seas began to die out. Among the latter were

certain forms which were probably the ancestors of the feather stars or sea lilies, to which in many ways they were similar. Their budlike bodies were anchored to the sea bottom by short, tapering stems, and sometimes they carried a circle of short, weakly arms, or tentacles.

The true feather stars or sea lilies, however, have survived to our own times, though they have dwindled in both size and numbers. There were a great many of them in the Ordovician seas, though not so many as there were to be later, nor so many different kinds of them. They were attached to the sea bottom by a long, tubelike, flexible stem made up of many joints. The small body at the free end of the stem was shaped rather



Photo by the British Museum

We call the Devonian Age the "Age of Fishes," but if we look at some of the fossil fishes from the rocks of that age, we shall hardly recognize them as fishes. The one above, for example, looks as much like those strange, extinct creatures called eurypterids and trilobites as it looks like a fish.

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## THE RECORD OF THE ROCKS

like a tulip—the name sea lily comes, of course, from the odd fact that this animal, like many other sea creatures, looked like a flower. The petals of this “flower” were many limy plates, differing in size, number, and shape in the different species. The arms which formed a circle round the top of the cuplike body, with the mouth in the center, were long, many-jointed, and feathery; from this fact comes the other popular name for these creatures—“feather stars.” Starfishes with short stumpy arms, some slender-armed brittle stars, and sea urchins, were also living in the Ordovician seas, but could not have been very numerous, for their fossil remains are rare.

### Creatures with Hinged Shells

One of the most striking things about the sea life of this time was the enormous increase in the lamp shells, or brachiopods (brāk't-ō-pōd'), which had already become important in the Cambrian period. Many of the Ordovician lamp shells are very like forms that had lived and died out in Cambrian times, but forms with hinged shells had grown greatly in number, and some of them had strengthened their shells with ribs.

The most familiar shell dwellers are the mollusks. In the Ordovician seas they too grew mightily in numbers. The most triumphantly prosperous of them all, as compared with Cambrian times, was the class to which the squid, octopus, and nautilus belong; they are called the cephalopods (sēf'ā-lō-pōd')—or the “head-footed”—because there grows out from the head of the animal a circle of arms or tentacles with cuplike ends which can cling or suck. No squids or octopuses lived at that time, however, but only the ancestors of the nautilus. There were many descendants of the members of this family that had lived in Cambrian times—and they all had straight or slightly curved shells. In North American seas some of them reached gigantic size, with shells a foot across in front and ten or twelve feet long!

### The First Creature with a Backbone

But we began by saying that it is to this Ordovician period that we trace the begin-

nings of the vertebrates, the creatures with backbones. Surely it was not such creatures as squids or brachiopods which developed into fishes and birds? No—we have been saving the ancestors of the vertebrates till the last. These earliest animals known to possess a rudimentary backbone—that is, something on the way to becoming a backbone—were called ostracoderms. It was only a little while ago that we found their fossils, in certain sedimentary rocks of the Ordovician period in Colorado, Wyoming, and South Dakota. In some ways these strange “almost-fishes” appear to have been akin to our present day hagfishes and lampreys, which are considered very primitive creatures. The ostracoderms were not very large, and had the head and fore part of the body protected by a shield made of large, angular scales with a highly enameled surface.

### A Strange Geography of North America

In North America, during this period, the sea many times ate its way over vast spaces of the land, and many times withdrew again, so that at one time or another nearly the whole continent north of Mexico was covered by shifting, changing seas. The same sort of thing was happening in Europe, and in a great part of Asia and parts of Africa, so that a map based on the records of the rocks would show us a series of islands of varying size—some with active volcanoes belching forth ashes and lava—in place of the great continents as we see them on the map to-day. The climate all over the world must have been mild and even, for the fossils show the same forms of life in the Arctic as in much warmer latitudes. In some regions there was still a great deal of volcanic activity, and in some parts of the world, such as Northern Asia, the land was a dry, barren desert.

But for the story of life, marvelously and mysteriously struggling upward through these uncounted ages toward the higher forms to come, the land did not yet matter. What mattered was the warm, hospitable sea. It was in the depth of the sea, and along the mud flats of the shore line, that the vast drama of life was being played.

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# *The RECORD of the ROCKS*

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## **Reading Unit No. 4**

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### **WHEN LIFE CLIMBED OUT ON LAND**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The birth of mountain peaks, 3-17-18

The first signs of land animals and plants, 3-18

The first cockroach, 3-18

The rise of the nautilus tribe, 3-18

The rise of fishes in the Silurian period, 3-19

#### *Things to Think About*

Why is it said that life began in the water?

What changes in the earth's scenery took place in Silurian times?

Why are Silurian rocks especially fascinating to fossil hunters?

What kinds of land plants began to grow in Silurian times?

What kinds of insects probably

appeared in the Silurian period?

When did coral reefs first begin to form?

How ancient is the pedigree of the pearly nautilus?

What fishes to-day are like the early Silurian fishes?

When did sharklike fishes first arise?

#### *Picture Hunt*

In what way is a modern shark different from its Silurian ancestor? 3-17

What distinguishes true modern fishes from the sharks? 3-17

What is the origin of amber?

3-18

How do we know what ancient insects looked like? 3-18

Of what advantage to an ancient fish was its suit of armored plates? 3-19

#### *Summary Statement*

In Silurian times great mountains were formed by the wrinkling of the earth's crust. These mountains are smaller to-day because much of their material has been washed away and carried to the ocean, to make new sedimentary rock. Silurian rocks are

very interesting because in them appear the first land plants, such as mosses and ferns. Besides, we find in them fossils of early fishes with the beginnings of backbones. The shark of to-day had its origin in Silurian times. Insects, too, came into being then.



## THE RECORD OF THE ROCKS



Photo by Sinclair Oil & Gas Co.

Many of our present-day fishes, though they have a very ancient lineage, look very little like their Paleozoic ancestors. But the shark family, which can trace its family tree clear back to the Silurian Age, has not changed so very much since that time—either in looks

or in skeleton. All of its skeleton except the backbone is made up of cartilage, or gristle, instead of the true bone found in most of our modern fishes. Above is the shark family's Silurian ancestor, which, as you can see, looks very much like a modern shark.

### WHEN LIFE CLIMBED OUT *on* LAND

*Locked in the Age-old Rocks There Lies the Fascinating Story of How Certain Early Forms of Life First Learned to Live on Land*

**L**IFE was born in the water. And for millions of years the water was its home. This is the story, as we make it out from the rocks, of the far-away time when living things first crept slowly up from the mud flats to the land.

It happened in the period which followed the Ordovician (ôr'dô-vîsh'ăn) period, that great age of backboneless sea dwellers. The rocks which tell the story of this dramatic event, and hence the period itself, have been named Silurian (sî-lû'rî-ăn), after an ancient British tribe, the Silures (sîl'û-rêz), who used to live in the western counties of England bordering upon Wales, in the region where the rocks of this age were first closely studied.

The Silurian period may not have lasted so long as the one before it, but in North-western Europe it saw one of the greatest mountain-making disturbances in the history of that continent. During this vast upheaval rocks of all previous ages, but particularly the Silurian mudstones and limestones, were bent and twisted like so much putty. The folding of the layers followed a great semicircular curve which extended from Ireland across England and Scotland, passed through the whole of Norway, and from there curved to Spitsbergen, the north of Greenland, Ellesmere Land, and Northern Alaska. The peaks of these mighty Silurian mountains have now been worn down by the winds and waters and

## THE RECORD OF THE ROCKS

ice movements of the ages, but they must once have been as towering and majestic as the Alps or Rockies are to-day. The crest of a great cliff which forms Niagara Falls is composed of Silurian rock; it is only one of the many magnificent records of this geological period in the United States.

Great oceans, vastly wider than those of to-day, still covered a large part of the earth in Silurian times, and these waters abounded in forms of seaweed and animal life. The fossil record tells of the old Ordovician forms continuing and developing, though not all faring alike by any means. Some groups which were abundant in the earlier period now began to dwindle, while others expanded. Certain new groups made their appearance, while certain old groups disappeared entirely from the earth.

Species and races come and go—we have read such records before. But here is the tremendous new thing, the thing which makes all the rocks after these different from all before: in the Silurian rocks we find at last undoubted traces of plants and animals that lived on land. Fossil remains of land plants have been found in the Silurian rocks of England, of North America, of Gothland in Sweden, and of Victoria in Australia. They are all simple, lowly forms, club mosses, ferns, and the like; there is no sign of trees, shrubs, or flowering plants, but only a mossy growth that began to collect in moist, sheltered places among the hills and valleys. The fossil remains of land animals of these Silurian times tell the same story of humble beginnings. There are no remains of back-boned animals; there are only certain fossils thought to be the remains of primitive May flies and cockroaches upon which the centipedes probably preyed, as their descendants do to-day.

Yet with the greater part of the land surfaces that we know to-day still covered by

the sea, it is not very surprising to find that the main forms of life whose fossil remains are entombed in the Silurian rocks are still those of sea-dwelling plants and animals. The plants are still represented almost entirely by the microscopic, one-celled diatoms (dī'ā-tōm), of which we heard in Ordovician times, and by a few lime-secreting seaweeds.

The records of the rocks show us that the hydroid (hī'droid) corals were now busy at the building of coral reefs, and that the beautiful sea lilies were also increasing in numbers and developing many new types to take the place of the cystoids (sis'toid) that had flourished in the Ordovician seas. Starfishes and sea urchins were slowly increasing, though they cannot as yet have been very common in the Silurian rock pools, since they have not left many fossils. The brachiopods

(brāk'ī-ō-pōd'), or lamp shells, still swarmed in the seas in enormous numbers and, dying, left vast numbers of fossil remains, which are often perfectly preserved and very beautiful in shape.

### The Teeming Life in the Silurian Seas

The familiar shell dwellers, or mollusks, were increasing in numbers and species all through this period, and it was in the Silurian seas that the members of the family to which our nautilus belongs reached the summit of their development—some 1,500 species of them have been recorded from the Silurian rocks. Since then these interesting creatures have gradually faded from the seas, until to-day they are represented by only one species, the pearly nautilus, found in tropical seas.

Among the "crust-clad" folk—the group to which our modern crabs, lobsters, shrimps, and prawns belong—the curious trilobites (trī'lō-bī\*), survivors from Cambrian times, were still very common, but were at last beginning to diminish. Slowly the great curve



Photo by American Museum of Natural History

Back in the early Cenozoic many of our modern insects which had just begun to appear on earth were caught in the resin which oozed from the trees. Some of the resin hardened into what is called amber, and the entrapped insects, now fossilized, are perfectly preserved for us in this transparent material.

## THE RECORD OF THE ROCKS

of their race life will sink from this time on, till in the Permian period they will disappear altogether.

While the trilobites were thus slipping from their high place, other crustaceans (krūs-tā'shān) were advancing. In particular there was another curious race, the eurypterids (ū-rīp'tēr-

id), weird creatures rather like scorpions, whose earliest records are found in Upper Cambrian rocks. All through the Ordovician rocks their fossils are found, and in the Silurian they increase in both size and number. But they too will then slide into a downward curve, to become extinct during the Carboniferous (kār'bōn-īf'ēr-ūs), or coal-forming, period. In these extraordinary creatures the head was broad and oval and carried on its upper surface a pair of compound eyes, while to the under surface were attached the jointed limbs and appendages for the capture and

chewing of prey. The body was long and tapering, and composed of thirteen movable segments, or sections; the last segment was developed into a long pointed spine in some species, and into a large, rounded tail fin in others. The eurypterids of Silurian days probably lived in fresh or brackish waters, as their fossil remains are found in sedimentary rocks that seem to have been formed from the deposits in such waters. It was also in the inshore waters of the Silurian seas of Europe that the ancestor of the modern American horseshoe crab flourished.

Next to the appearance of life on land, the most interesting thing in the Silurian record is the story it tells of the coming of more and

more animals with backbones. For it is from these forms, which have been barely hinted at in earlier records, that the higher animals will later develop. We found a few ostracoderms (ōs'trāk'ō-derm), most primitive of fishes, in the Ordovician period; but now the fishlike creatures became much

more numerous. They belonged to the great group of round-mouthed fishes, dwellers in fresh and brackish waters. The only modern creatures of this group are scaleless eel-like forms, the lampreys and the hagfishes; but the early Silurian and Ordovician species were more fishlike in appearance.

These strange fishes have no bony jaws, but a round sucking mouth. They have no bony internal skeleton, or true paired fins, and only a single organ of smell instead of a pair, such as all other backboneed animals possess. Their gills or breathing apparatus consist of pouches within the body, and circular or

slitlike openings outside behind the head. Of the forms living in Silurian times, some were covered with thin, four-sided scales. Others were cased in a thick armor of bony plates. Others again had a large head shield somewhat like that of a trilobite.

### The First Real Fish

But already in the Silurian seas where these fishlike things roamed, there were swimming also the first true fishes. We know this because we have found fossil fin spines in the Silurian rocks of both North America and Europe. These first true fishes were a sort of primitive shark.



Photo by the British Museum

Here is one of our strange-looking Devonian fishes. Instead of scales he wears a suit of armor made up of hard plates. He was not a very active swimmer, but probably plowed along sluggishly through the mud.

# ***The RECORD of the ROCKS***

## **Reading Unit No. 5**

### **WHEN THE FISHES RULED THE EARTH**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

The kind of fossils found in Devonian rocks, 3-21  
Why the Devonian is called the "Age of Fishes," 3-21  
What the Old Red Sandstone contains, 3-22  
How the seas once covered most of the earth, 3-22

Devonian land plants, 3-22-23  
Why land plants leave few fossils, 3-23  
Remarkable Devonian fishes, 3-23-24  
The most abundant fossils found in Devonian rocks, 3-24

#### ***Things to Think About***

What difference is there between fossils found in Devonian rocks and those found in the Old Red Sandstone?  
How do you explain the presence on a continent of large salt lakes?  
What part of the world was under

water in Devonian times?  
Why are fossils pretty much the same in Devonian limestone the world over?  
What plants of to-day resemble the Devonian plants?  
How were Devonian fishes protected in Devonian times?

#### ***Picture Hunt***

In what important respect is this fossil fish similar to those now living? 3-21  
What plant in this picture is commonly found to-day? 3-22

How long ago did these fossil ferns live? 3-23  
How do these fossil fern leaves compare with leaves of modern ferns? 3-23

#### ***Related Material***

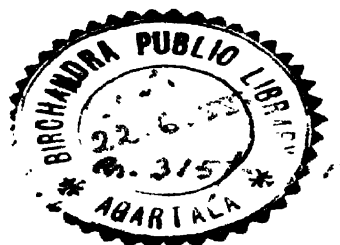
Look at the picture on page 3-20.  
Can you explain the presence

of fossil mollusks on mountain tops?

#### ***Summary Statement***

In Devonian times most of the earth was under vast seas. Tremendous upheavals raised land into mountains which later sank again. Limestone rocks were laid down in layers and in them we

find fossils of fernlike plants of large size. With them we find innumerable fossils of shelled mollusks and many fishes, most of them with armored plates.



## THE RECORD OF THE ROCKS



Photo by American Museum of Natural History

Many of the later fossil fishes look almost exactly like fishes living to-day. The fish above is so well

preserved that the impression of every bone and even of the eye socket is clearly outlined.

### WHEN *the* FISHES RULED *the* EARTH

*This Will Tell You All about the Strange Age When Mother Nature, Beginning in Good Earnest to Experiment with Backbones, Filled the Waters with Fishes*

**T**HE Age of Fishes is named after Devonshire, in the southwestern part of England. That is because of the vast and useful labors of three distinguished British geologists, Lonsdale, Sedgwick, and Murchison, who early in the nineteenth century made a study of some rocks of this period in Devonshire, and named the ages when they were formed the Devonian (dē-vō'nī-ăn) period. These Devonshire rocks are said to be of "marine origin" because they were once under the sea and so contain fossils of salt-water animals. There are other rocks of this same period—the Old Red Sandstone of Scotland and Wales, which contain the fossils of fresh-water creatures. The layers of rock that were formed during the Devonian period lie just above the Silurian (sī-lū'ri-ăn) rocks of which we have spoken on an earlier page; so they make the next chapter of the great stone book we are trying to read. They still have much more to tell us about life in the seas and lakes than

of life on land; but they show a very much greater advance toward the higher forms of life than we have yet met with. Indeed it is because of the amazing development of backboned water animals that this geological period is often spoken of as the "Age of Fishes."

Many more of these fishes lived in fresh water than could have done so in earlier ages. For all over the world a gradual change was taking place. The floors of the Silurian seas were being gradually upraised to form land, only to be cut through by streams and slowly worn down again. Along some coast lines, areas of the sea became so shallow as at length to form immense lagoons which gradually became cut off from the open sea and turned into great inland lakes that lasted for long, long ages. In other parts of the world, however, there were areas which throughout the Devonian period remained deep, clear seas. It was in these regions that limestone was formed on a grand

## THE RECORD OF THE ROCKS

scale and that the fossil record of the salt-water life of Devonian days is entombed. At the same time the great masses of the Old Red Sandstones were laid down on the floor of the great lake basins, and in those masses we find the record of the plant and animal life of fresh and brackish waters.

During a great part of the Devonian period more than half of what we see marked as land on a modern map was covered by these seas of varying depth and these great lakes. Again and again over immense periods of time the lands gradually rose from the waters, sank into them, and rose once more. Toward the close of the period much of the drowned land, particularly in Asia, had risen above the surface of the sea, and had begun to form the vast continents of the next geological period, the Age of Coal. But in Devonian times we must

still think of the earth as mostly sea.

The climate must have been much the same as that of the ages just before; that means it was on the whole mild and uniform, without any such distinct zones of intense heat and bitter cold as exist to-day. If this had not been so, the fossils found in widely separated latitudes would differ more than they do.

It is in the Devonian that we first find land plants developing beyond the simplest forms. And how their fossils have increased in

number since Ordovician (ôr'dô-vîsh'ân) times! They are still not very high forms. Most of the early ones of this period either had no leaves at all or else had leaves that were small and scalelike. The majority of the Devonian plants that have left any fossil record were spore bearers—mosses,

true ferns, stone-works, horsetails, and club mosses. Most of them lived in moist or swampy places, where they could keep their roots and stalks in the friendly water. Many were small, but others grew to considerable size—beginning to stretch toward those giant ferns and mosses we shall hear of in the Age of Coal.

There were seed-bearing plants in the Devonian too. They are called pteridosperms (těr'î-dô-spûrm'). They looked and grew much like ferns, especially the tree ferns of the Tropics. One North American species had round

stems thirty to forty feet high and as much as three feet in diameter, and bore crowns of long, fernlike fronds often nine feet in length. It may be that these remarkable plants had both seeds and spores borne on leaflets of different shapes.

### Strange Plants of Long Ago

We have also found fossil remains of a plant whose fern-shaped leaves are very like those of the modern Japanese "maidenhair," or ginko tree, and whose stems show a woody

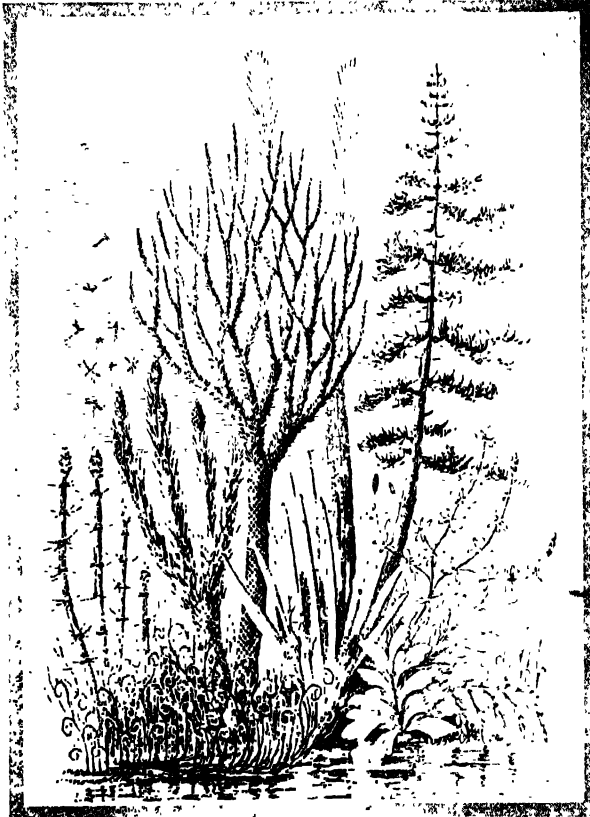


Photo by New York Botanical Garden

In this Devonian plant group we see many of the ancestors of the better-known Carboniferous plants. Some of these plants have never died out, although they have become very small and insignificant. The horsetail to the left, for example, still grows in damp places in our present-day world.

## THE RECORD OF THE ROCKS

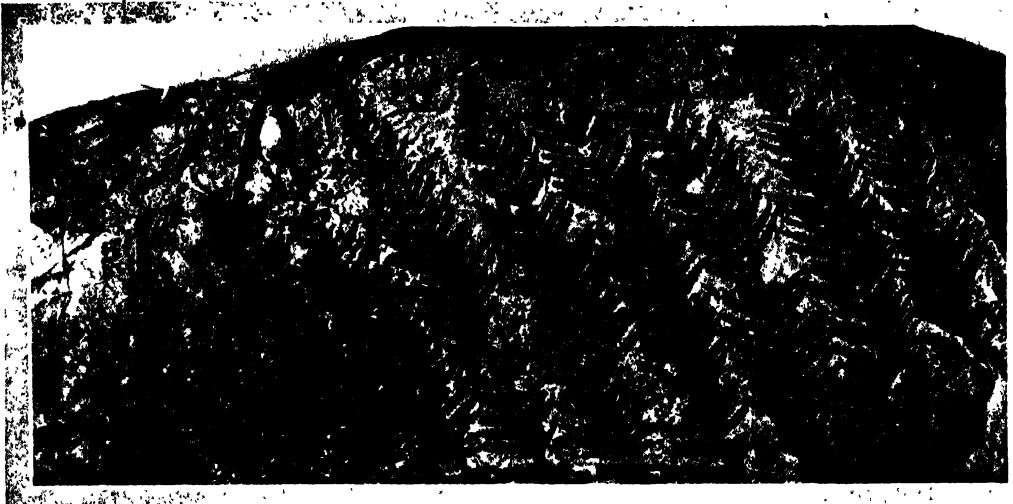


Photo by American Museum of Natural History

Could you tell these from freshly dried and pressed ferns? They are Devonian fossil ferns that were

preserved just as they fell. And so they have been drying for some 250,000,000 years!

structure like that of some of our modern cone bearers. And one of the most curious of all the plants which clothed the Devonian swamp lands was a gigantic horsetail called *Calamites* (kāl'ā-mī'tēz). It had a slender stem twenty feet or more in length, and grew in dense thickets on the sandy, muddy flats bordering the swamps. The stem was ribbed and jointed on the outside, and from the joints grew out long, narrow, simple branches which in some species bore a ring of small branchlets or the beginnings of leaves. Can you picture a swamp clothed in this strange vegetation?

### The World's First Trees

On the slopes of the better-drained land grew certain cone-bearing trees. But of the other plant life of the uplands we know little or nothing, for it is hardly ever found in fossil form. Plants growing in such situations usually have to be swept down by flood or avalanche to some flooded plain or river mouth if they are going to become fossils preserved in the gathering sediment; and naturally not many of them reach the muddy flats without being destroyed. On the other hand, plants living on the plains, in moist meadows and marshes, or on the banks of rivers and lakes, are quickly covered up and preserved, and so have left a far more

complete record of their beginning and progress throughout the ages.

As for the land-dwelling forms of animal life, the records of the Devonian rocks show but little difference or advancement from Silurian times. The fossils are still only those of centipedes and certain primitive insects, the ancestors of May flies, cockroaches, and grasshoppers. Other insects may quite probably have existed, but if they did they failed to leave any fossils. In the same way the Devonian rocks have yielded as yet but little evidence of backboned land dwellers, though it is quite possible that those higher forms had come into existence, at least toward the close of the period. In how many places our great book is blotted or torn!

### Fishes Grotesque and Fascinating

But this being the Age of Fishes, it is high time we went back to sea. Would it not be fun if we could let ourselves down into the Devonian waters in a diving bell? We should see a throng of strange and fascinating sights. Fishes of varying sizes and of many curious shapes would swim about us in the brackish waters.

Some of the armored forms that had lived in Silurian waters had doubled in size, and many new species appeared for the first

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## THE RECORD OF THE ROCKS

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time. Sharklike fishes from two to five feet long increased in numbers and species and must have preyed upon the slower fish, just as they do to-day. Then there was a race of giant fishes which, unlike any fish existing to-day, could nod their heads up and down without moving their bodies. One of the largest Devonian fishes sometimes measured seven or eight feet in length. It was clad in scales three inches long, two inches broad, and over one-eighth of an inch thick -- an armor that might serve the most gigantic of crocodiles.

### A Little Winged Fish of Long Ago

In contrast there was a queer little winged fish, only a few inches long. It had a body rather like that of a small, thick turtle, protected both above and below by stout bony plates; and it wore its pair of fins or paddles so far forward as to make it look headless. An odd creature indeed! Its paddles cannot have been of much use for swimming, but with their sharp-pointed blades may have been a means of defense. It is thought that normally they rested against the creature's side, and were erected only in times of danger or alarm. The head-buckler fish was another queer form, with a head shield shaped like a curved knife. Its body was slender and covered with enameled scales, and the plates on its head formed a huge buckler, sometimes quite a third of the length of its body.

The lungfishes, which have dwindled to-day to a few kinds living in the fresh waters of Australia, Africa, and South America, were very noticeable forms in the Devonian waters. These lungfishes, or "double breathers," can breathe both air and water, and so they can survive in mudholes and similar places during times of drought.

Now if we tried to tell you all about the Devonian fishes, we should be filling all these books with them. Perhaps you already have a notion of their many and fantastic forms. Yet with all their variety, they were much more primitive than most modern fishes. Among them there were none of the type we call bony fishes; yet this is the type to

which the vast majority of both sea and fresh-water fishes belong to-day.

The fishes get most attention when people talk of the Devonian seas, because they were new, and so very interesting. But all the time the different groups of backboneless creatures were carrying on their lives as before, and all the time new species of them were taking the place of earlier species that had already passed their prime and were beginning to die out. The graptolites (grăp'-tô-lit) which had swarmed in the seas of earlier periods dwindled away and died out in the Devonian; the corals, on the other hand, increased greatly both in size and numbers, and their fossil remains are abundant in the great limestone formations of this period. The beautiful feather stars must have formed dense though tiny forests or undersea gardens on the floors of many Devonian seas, for so great is the multitude of their remains that many beds of limestone are composed almost entirely of them.

It was in the seas of the Devonian period that the ancient race of lamp shells gained the height of their development and numbers -- it is they and not the fishes which are the commonest marine fossils of the period. The mollusks were also making steady upward progress in both numbers and species, and it is in the Devonian strata that we find the very early kinds of those beautiful coiled shells called ammonites (ăm'on-it), which often look much like nautilus shells.

Among the crustaceans (krūs-tă'shăn), or "crust-clad" animals, the trilobites (tri'lô-bit) so abundant in Silurian seas, were now fast dying out. The scorpionlike eurypterids (û-rîp'tēr-îd), on the other hand, now reached their greatest development, some growing fully ten feet long.

So we see that the long Devonian period was one of change and progress both in the sea and on the land. Indeed the more we learn from the buried records of the rocks, the more we realize how all down the ages this rhythmic ebb and flow of life has gone on. "The old order changeth, yielding place to new"--but what the next changes were is another story.



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# *The RECORD of the ROCKS*

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## Reading Unit No. 6

### WHEN MOTHER EARTH LAID IN HER COAL.

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

When coal was made, 3-26-29  
How coal was made, 3-27-28  
How plants were buried during the Coal Age, 3-27  
The vast swamps of the Carbon-

iferous Times, 3-27  
What peat is, 3-28-29  
The age of giant ferns, 3-29  
Two-foot dragon flies, 3-29  
The first amphibians, 3-29

#### *Things to Think About*

What happened to dead plants in the Coal Age swamps?  
Where can we see to-day what went on in the Coal Age?  
What must happen to dead plants in order that they may turn into coal?  
What caused the formation of many "seams" of coal?

How is peat formed to-day?  
What kind of plants made our coal?  
Which of our familiar insects had giant ancestors?  
In what kind of climate did Carboniferous plants and animals live?

#### *Picture Hunt*

What plants do these resemble?  
3-26  
Where are coal and peat being made to-day? 3-27  
Why are coal seams separated

by layers of shale or sandstone? 3-8  
Why are plant fossils often found on pieces of coal? 3-29

#### *Related Material*

Why may coal be called "bottled sunshine"? 2-41-45

The coal mining industry of to-day, 9-435-47

#### *Summary Statement*

The formation of coal took place millions of years ago in swamps, where giant ferns and fernlike plants lived and died. They rotted slowly and were soon covered by other dead plants. At times the land sank below the water and mud covered the dead plants. Eventually these plant remains hardened into coal and

were covered by rock. To-day, peat forms in the same way in swamps. Giant insects flew through the jungles of the Carboniferous period. Then a new form of animal appeared, which could live both in water and on land. It became the ancestor of our frogs and salamanders as well as of other land forms.

## THE RECORD OF THE ROCKS



Photo by Field Museum

This picture shows you how a landscape looked in a far-off age long before there were men on earth to see it. Carboniferous forests like this one are de-

scribed in many of the pages of these books—particularly where we speak of coal; for most of the coal we use to-day was formed from their pulpy trees.

### WHEN MOTHER EARTH LAID *in* HER COAL

*In Steaming Swamps and Tangled Jungles She Imprisoned the Sunshine That You and I Set Free in Our Furnaces To-day*

**I**T PROBABLY would never occur to most of us to think of a lump of coal as a page from the great Book of the Rocks, in which the earth's history is written. But after you have read this story of the Age of Coal, you will see that the coal we shovel so carelessly into the furnace is really a loose leaf from that mighty book.

Because coal is so important to us, the coal beds—or “coal measures,” as they are called—have received a great deal of study. So geologists probably know more about the

period when they were formed than they know about any other period in the earth's history. They call it the Carboniferous (kär'bōn-ĭf'ēr-ūs) period—the Age of Coal. It followed the Age of Fishes, or the Devonian (dě-vō'nĭ-ăn) period, which we have already told you about on earlier pages. At first geologists supposed that coal was formed only in the Carboniferous period, but when they had studied and explored the rocks more carefully, they discovered that coal seams have been laid down in other and later ge-

## THE RECORD OF THE ROCKS

ological periods. Still, the richest and most valuable beds of coal so far discovered seem nearly all of them to have been developed in Carboniferous times.

The Coal Age must have been vastly long, for the layers of different kinds of rocks associated with the coal measures are enormously thick. Indeed, so complex are the different layers of rock belonging to this period that geologists have thought best to separate them into two divisions, called the Upper and Lower Carboniferous. The Upper Carboniferous layers contain the "coal measures." The Lower Carboniferous includes great beds of limestone and sandstone. These are all sedimentary rocks; the fossils embedded in most of them show that they were formed from deposits laid down in the shallow fresh or brackish waters of vast lakes and lagoons, and along the shores of wide river mouths. Some of the limestones, however, must have been formed on the floor of deep and clear seas that swarmed with animal life.

"Coal," wrote a great geologist, "may well be likened to bottled sunshine." Sunshine bottled millions of years ago in the vast swamps of the Carboniferous world, and now unbottled to crackle and flare in our grates, warming and cheering us! Is it not a thing to marvel at? This is how it came about.

### The Marvel in a Lump of Coal

The record of the rocks shows us that during the Carboniferous period the earth's crust in eastern North America and other regions was very slowly and steadily sinking, and as it sank, sediment was deposited in the shallow waters along the gradually sinking shores. As the waters advanced and the shallows

filled up with sediment there were formed wide tracts of marshy, badly-drained land just above sea level. In these vast swamps flourished the strange, luxuriant growth of plant life whose accumulated remains went to form the coal beds as we know them to-day. For as each generation of plants died it sank into the swamp. Slowly through the long ages one jungle followed another. Not once but many times the land had a period of sinking; each time there would be formed a fresh layer of sediment, composed of the remains of the more ancient rocks, forever being broken and worn down by the action of the atmosphere and similar causes.

We can see something very like this process going on to-day, in the mangrove swamps which sometimes stretch for many miles along low shores in warm lands. Often the mangrove trees form dense jungles reaching twenty or thirty miles back into

the land. Along the coast of Florida, for instance, a ribbon of mangrove swamp from five to twenty miles wide winds for long distances around the shallow creeks and inlets of the coast, and as time goes on the creeks and inlets grow choked with the accumulating waste. The same sort of thing goes on in various parts of tropical Asia and along parts of the western coast of Africa.

On any of these warm low-lying coasts the mangrove flourishes in the sea water right down to low-tide mark, forming a dense mass of matted vegetation, ever creeping forward as the trees spread outward into the shallow, muddy waters. Up among the branches orchids, mosses, and ferns find a hold and grow on the bark of stems and branches, and birds build their nests and rear their young.



Photo by American Museum of Natural History

Geologists wonder where on the surface of the earth coal is starting to form to-day. The most likely places seem to be the peat bogs and swamps of temperate and cool climates. Such a swamp is shown above. In jungles of tropical lands the fallen plants decay so fast that very little of their material is preserved to form the coal beds of later ages.

## THE RECORD OF THE ROCKS

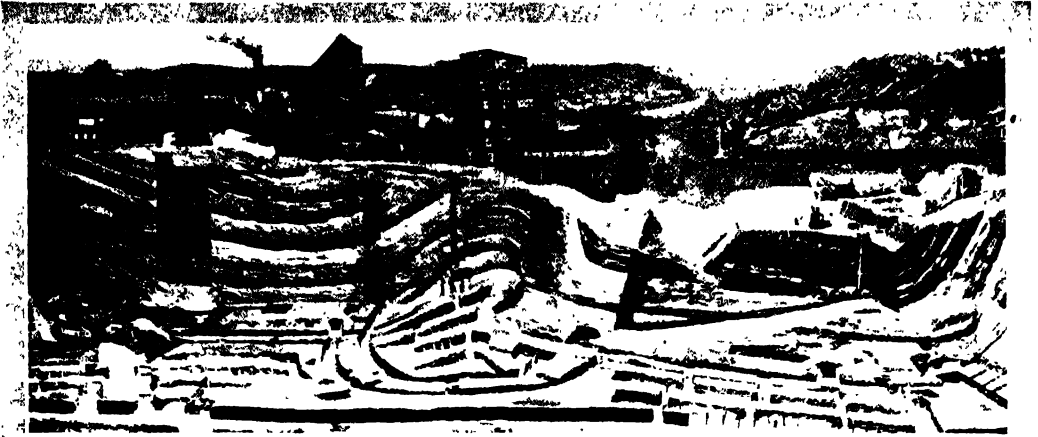


Photo by the National Museum

This picture shows you how the layers of coal would look if you could see a cross section of a coal mine. The black layers are coal, and the light layers are ordinary sandstone or shale. Each coal bed repre-

sents the compressed plant material which came from thousands of years of uninterrupted growth. The sandstones were laid down when the sea had covered the land, burying the fallen plant material.

Below, where the tangled roots and stems reach down into the mud and water, a queer company of fishes, crabs, barnacles, mollusks, and other animals have their home. Where this under-water tangle is densest it filters the sediment from the water and holds it among the matted roots and stems. In this way the mangrove forests are always building up new soil. In the damp forest glades where this process is going on, swarm innumerable insects, and spiders weave their snares and hunt down their prey.

### What Is a Seam of Coal?

Now except for the presence of men and birds and mammals, these gloomy mangrove swamps give us some picture of the conditions under which the coal measures must have been formed. For every bed of coal is composed almost entirely of compressed vegetable matter and rests on a bed of clay in which are found the bases of the stems and the roots of the plants and trees. This bed of "under-clay," as it is termed, was once an old land surface, perhaps the bottom of a swamp covered with a dense vegetation. The coal bed itself is the slow accumulation, through long ages, of the leaves, seeds, stems, and trunks of this vegetation, now hardened and pressed down into a fraction of its original bulk by the pressure of rocks above. The rocks which thus pressed down on the coal

are themselves sand or shale made up of sediment slowly laid down as new ground, as the old ground slowly sank beneath the water. As time went on they in turn were covered by another bed of underclay supporting a luxuriant vegetation.

This process was often repeated again and again, through immense periods of time. In many coal fields into which miners have sunk shafts, it is possible to see a whole series of these layers, or seams, of coal, each resting on its bed of underclay and covered above by beds of sand and shale. In some mines the total thickness of the coal is some hundreds of feet, usually divided into a number of "seams," each only a few feet in thickness.

### What Is a Peat Bog?

The peat bogs in the northern parts of North America and Europe probably show us another way in which some of the coal beds were formed; for these peat bogs, too, are the result of the gradual piling up of plant remains. They often reach to a depth of forty or fifty feet and cover many thousands of miles. Some of them must be very old indeed, for they contain the remains of plants and animals long since extinct; probably they began to form as the ice receded at the close of the Ice Age. Generation after generation of plant life flourished and died, leaving its remains to build up the ever-deepening mass.

## THE RECORD OF THE ROCKS

Sometimes this waste accumulated more swiftly, sometimes more slowly—it depended on the climate, the slope of the land, the drainage of the soil. It is thought, for instance, that in some Danish peat bogs it took at least 250 or 300 years to make a layer of peat that to-day is only ten feet thick.

So by looking at mangrove swamps and peat bogs we can begin to understand the story of coal. We can begin to imagine the long, slow method of patient Nature as she bottled Carboniferous sunshine that was going to be used after millions of years in a very different world.

But can we imagine what those antique swampy jungles were like? Can we see in our mind's eye those strange forests that no man ever saw with his bodily eyes? We have many fossils to help us imagine what the landscape must have been like in those days—many more than for any earlier period. And as the picture rises around us, we rub our eyes and think we are in Wonderland. For these are not forests of pine or maple or anything else like a modern tree, but of fantastic giant mosses and ferns. No, it is not Wonderland; it is Brobdingnag, the Land of Giants which Gulliver visited, where the people were thirty feet tall! Here are enormous club mosses, gigantic horsetails, and the huge ancestors of our tropical cycads—tree ferns and monkey-puzzle pines. Here too are primitive seed-bearing plants with fernlike foliage; these may have been the ancestors of our flowering plants. And between and beneath these dreamlike trees is a luxuriant spreading undergrowth of true ferns and mosses of many sizes and forms.

### A Strange Primeval Forest

A strange silence, too, must have brooded over these forests and swamps; no song of bird or call of mammal sounded, for neither had yet appeared on the earth. There was

only the sighing of the wind in the trees and the rustle of the reeds, or the distant boom of the surf on the shore, punctuated perhaps by the shrill chirp of some ancestral form of cricket. Gigantic dragon flies with a two-foot spread of wing darted silently backward and forward through the open glades, and

swarms of May flies, five or six times the size of their modern descendants, danced and hovered above the surface of the pools. Huge cockroaches hid beneath the fallen trunks, and spread their wings in flight at dusk. Spiders and scorpions took their toll of the abundant insect life.

In this fantastic world of giant insects and towering ferns the first land vertebrates, or backboned animals, seem to have appeared. They were only half land animals at that, for they were amphibians (ăm-fil'ī-ăn), creatures like frogs and toads which live part of the time on land and part of the time in the water.

Some of them must have grown to considerable size during the Coal Age, to

judge by the record of the rocks. Not only their fossil skeletons, but even impressions of their skins have been found. So we know a good deal about them.

Amphibians that lived on the banks and swam in the forest pools of the Coal Age resembled salamanders and lizards in general appearance, and varied in length from two or three inches to eight or nine feet. They have been called stegocephalians (stĕg'ō-sĕ-fă'lī-ăn), from two Greek words meaning "roof-headed," for their heads were protected by a complete covering of bony plates. The bodies and tails of many of them were also more or less incased in bony armor. It would be interesting if we could find fossils of the very earliest amphibians, the ancestors of the Carboniferous forms, but so far no one has found anything in the earlier rocks that he can be sure is such an ancestor. So we do not know yet by what steps they climbed



Photo by New York Botanical Garden

Often on the surface of a lump of coal you can see the delicate outlines of a fossil plant—such as is shown above. Many of these early plants of the Carboniferous Age look like ferns.

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## THE RECORD OF THE ROCKS

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up out of the water. It is another lost page in the Book of the Rocks.

And while all these strange and exciting things were happening on land, what of the sea, that ancient home of all life, whether of plants or animals? The open seas and the coastal waters still swarmed with varied forms of animal life, descendants of the creatures of earlier ages. Fishes increased enormously; more than a hundred species have been found in the carboniferous limestones. There are all sorts of fishes, and many of the species are decidedly more advanced and complex than any we have met before in our travels down the ages.

### Strange Undersea Gardens of Lilies

As for the lowlier creatures of the waters, they too abounded—as indeed they do to this day. Sea urchins and starfishes increased greatly, and their cousins, the graceful sea lilies, reached the very height of their development. The sea lilies must have made vast gardens of weird animal-flowers on the floors of the Carboniferous seas, for in many places the limestone rocks are made up almost entirely of their fossil remains. Cup corals that lived alone like solitary flowers were numerous, and so were the reef-building corals which labor only in clear and temperate seas.

Some of the ancient sea tribes which we have met in every period almost since the beginning are now sinking toward extinction at last, as if to make way for the higher forms that are appearing. Such are the lamp shells, which are now much fewer in number; and the ancient trilobites (trī'lô-bīt), with their puzzling, great eyes, have become nearly extinct. At the same time other shell-clad creatures, such as forms much like modern crawfishes, shrimps, and horseshoe crabs, are prospering. In these seas lived the ancestors of practically all the backboneless animals, great and small, which live in the ocean to-day.

The record of all this and much more is written in immense deposits of limestone rocks of the period, crowded with fossils that prove the rocks to have been formed in the sea. In Central Europe and in Ireland there are great beds of these rocks piled on top of each other to a depth of hundreds of feet, and in America they reach a thickness of several thousand feet. In Western North America and also in China, the Carboniferous rocks cover thousands of square miles. They lie in flat or gently rolling sheets and often reach an immense thickness. So we know that the Carboniferous seas must have stretched far and wide.

Where the beds of marine limestone grow thinner, they are frequently separated one from another by layers of shale, often amazingly rich in fossils. These seams of shale grow thicker and thicker toward the shore lines of that ancient ocean, and slowly they become more and more like coal, until at last they *are* coal. At this point we find them associated with clay, sandstone, and other things typical of the coal measures—and we know that here were the coal swamps and not the open sea.

### A Moist, Volcanic World

Through all the immensely long time it must have taken to build up these Carboniferous rocks, the earth was still warm and moist and restless with volcanic energy. In both the Old World as we know it and the New, there were great flows of lava, much granite was formed, and thick beds of ashes were laid down. In these, too, fossils were preserved. The climate must have been even and mild and very moist. Such a climate would be the best possible for the luxuriant growth of plants in the coal swamps. Never before or since have conditions been quite so good for that purpose—otherwise we should have had more than the one Age of Coal.

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# *The RECORD of the ROCKS*

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## Reading Unit No. 7

### MOTHER NATURE INVENTS REPTILES

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The emergence of reptiles, 3-32-35  
Why reptiles are true land animals, 3-33  
A survivor of the Permian reptiles in New Zealand, 3-34  
The habits of the Permian rep-

tiles, 3-34  
The first turtles, 3-35  
The lost continent of Gondwana, 3-35  
The unusual climate of the Antarctic of the past, 3-35

#### *Things to Think About*

Why is the Permian period famous?  
In what important way do reptiles differ from frogs and toads?  
How were Permian turtles protected from enemies?  
What continent once existed along

the Equator?  
How do we know that the climate along the Equator used to be different from what it is today?  
Why do scientists say that the region at the South Pole once had a tropical climate?

#### *Picture Hunt*

From which group of animals did reptiles arise? 3-32  
What modern reptile may have had its origin in the Permian period? 3-32

Why is the tuatara called a "living fossil"? 3-33  
What does the presence of rounded boulders tell us about the past? 3-34

#### *Summary Statement*

In the warm, moist Permian period amphibians flourished. From these primitive animals an animal developed that no longer needed gills. Instead, it had lungs from the moment it hatched from the egg. These were the first reptiles. Our present-day al-

ligators and lizards still resemble these first reptiles. In the Permian period the world's climate grew cooler. There were glaciers even at the Equator. Continents sank below the seas. It was a period of great change.

## THE RECORD OF THE ROCKS



Photo by Fiehl Mu

This Permian landscape is swarming with the highest animals that had developed so far. Near the end of the Paleozoic era there developed from the amphibians—the ancestors of our frogs and newts—a higher order of animals called reptiles. Above are two kinds of reptiles that lived in the Permian swamps. They were not nearly so large as the later reptiles, the dino-

sours; they were only six to eight feet long! Those to the left look very much like our modern alligators, but they are much simpler in structure. Those to the right are among the most odd-looking creatures of geologic time. Their strange frills are supported by spines that grow from the backbone. Perhaps these were developed as a protection for the animal's back.

## MOTHER NATURE INVENTS REPTILES

*In the Great Rock Book That Tells the Thrilling Tale of the Rise of Life upon the Earth, We Come to a Chapter Written When One Vast Continent Stretched along the Equator*

**T**HE great Book of the Rocks, in which the story of life upon our earth is written, is divided into five enormous volumes. We have already tried to tell you something of what the first three volumes contain. In the first volume, or era, we find no fossils, and but few in the second. In the third volume life can be traced as it climbed through higher and higher forms until Mother Nature learned to make the fishes and laid down the great beds of coal that we are burning up so rapidly to-day.

But we have one chapter of that third volume still to read. It is called the Permian (pŭr'mĭ-ăn) period, for it is named for the province of Perm, in Russia, where enormous

areas of rocks made during that period were studied about a century ago. With this Permian chapter, the Paleozoic (pā'lē-ō-zō'ik)—or Ancient Life—volume of our record comes to an end. But it so happens that in this same chapter the age to follow—the Age of Reptiles—is beginning to dawn. So the pages of this chapter in the great Book of the Rocks are of stirring interest, since they tell us of the passing of an old order of life, and of the beginning of a new one.

In order that we may better understand the importance of this chapter in the earth's history, it will be a good idea, before turning its pages, to look back for a moment and remind ourselves of the chief points in the



## THE RECORD OF THE ROCKS

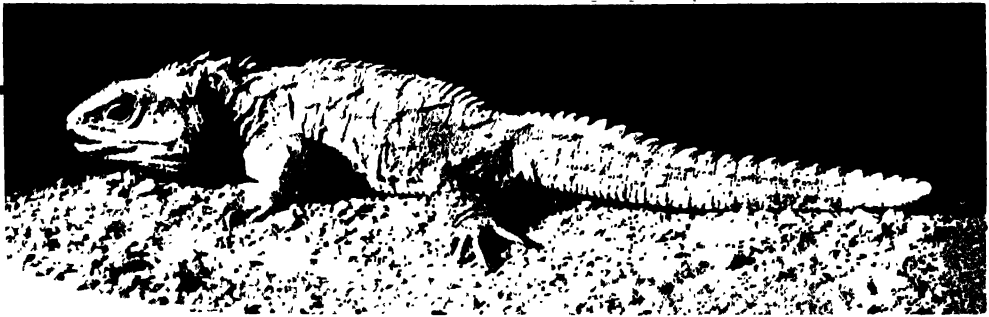


Photo by American Museum of Natural History

This odd little tuatara may look like an ordinary lizard, but for scientists he is much more important than that. He is the last survivor of a very primitive race of reptiles that began its existence in Permian times. He still has the primitive bone structure and strange jaw

hinge that his far-off ancestors had. Nature found out much better ways for making her later animals, but she left the tuatara practically unchanged; so he makes a very interesting and enlightening "living fossil" that scientists may study.

story so far. We have learned how the very earliest rocks that are known hold the record of the gradual cooling of the earth's surface and of the appearance of the first simple forms of life in the waters. Slowly but surely through each period that followed, the steady increase of plant and animal life in the waters has been unfolded in the record of the rocks.

### A Record of Progress

At last, in the Carboniferous Age, practically every known class of sea animal was represented, so that the waters of that time had become thickly populated and had already gained that perfect balance of plant and animal life which they have kept ever since. The Paleozoic era covered, in fact, the birth and completion of animal life as it was to exist in the sea. To be sure, many of the old forms were to die out during later periods, and give place to new ones. But this has been only the natural program of progress within each separate class of marine plant and animal life. No other great types or classes were to appear. Henceforward the scene of great changes was to shift from the seas to the dry land. Already in the Coal Age a luxuriant vegetation had begun to spread over the land, and the first backboned land animals had come into being. Now in the later Permian rocks we shall find the fossils which tell us that the great changes in land life have begun. And in every period after this one we shall find that the record of

the rocks is one of gradual progress and development of plant and animal life on land.

The Permian rocks show us clearly that a great advance in life was taking place, for the fossil remains of those queer triangular-headed, large-eyed creatures, the stegocephalians (stĕg'ô-sê-fă'li-ăn) and labyrinthodonts (lăb'î-rîn'thô-dönt), show a remarkable increase in numbers and in size. Some, indeed, must have been truly formidable animals, for their skulls measure fully two feet in length. These giant creatures, which, strange as it may seem, belonged to the same race as our toads and frogs, dwelt in the swamps and rivers of warm lands that to-day form the rocks of part of North America. In Europe, on the other hand, the stegocephalians hardly grew so big as the modern monitor lizard.

### When Animals Learned to Live on Land

But more important than the prosperity of the race of toads and newts is the first appearance of true reptiles; and it is in the Permian rocks that we meet with the first undoubted reptile remains. Reptiles are real air breathers throughout their lives; they do not go through a tadpole, gill-breathing stage when they live in the water, as toads and frogs do. Their appearance means that at last animal life has learned to live entirely on land.

Some of these early reptiles measured scarcely twelve inches in length. But others

## THE RECORD OF THE ROCKS



Photo by Nature Magazine

Near the close of the Paleozoic era great sheets of ice covered many of the lands of the Southern Hemisphere. Such ice sheets can carry tremendous boulders.

Those in the picture above were left stranded when the ice melted. Many ages later trees sprang up and the rocks were rounded by weathering.

seem to have been as much as five or six feet long, and these species were more or less like their lizard and crocodile descendants of to-day. There is still living in New Zealand a reptile which in general habit and appearance is very much like the Permian ancestors of all the reptile race; it is the tuatara (tōō'ä-tä'rä) lizard—and for scientists it is much like having a living fossil to study and observe! Unfortunately this curious creature is fast dying out.

### The Forefathers of Mammals

If we could explore all the different layers of rock that were formed during the Permian period, we should be able to trace step by step the way in which reptile life advanced. Even as it is, we can make out many species, some of which point toward the mammals which were to come in time. Certain species of Permian reptiles, indeed, grew to be so much like mammals that geologists have called them theromorphs (thē'rō-mōrf), or

“beast-shaped,” and theriodonts (thē'rī-ō-dōnt'), or “beast-toothed,” reptiles.

Some of the beast-toothed sort seem to have been flesh eaters, and as they were probably equally good as swimmers and as runners, they must have been unpleasant neighbors. Very often their more peaceable vegetarian relatives must have had to race for their lives to escape from their literally “devouring” attentions. Small wonder then that as the centuries passed, many of the vegetable eaters developed a bony armor of plates and bristling spines to protect them from the eaters of flesh. One sort had a particularly formidable suit of armor, with bony crests down the back supported by a row of spines growing out from the backbone. These pelycosaurians (pěl'i-kō-sō'rī-ăn), as they are called, were a lizard-shaped race which lived in many parts of the world, but gained their greatest size and variety in North America. They died out toward the close of the period.

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## THE RECORD OF THE ROCKS

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It was during the Permian period, too, that the ancestors of turtles and tortoises probably made their first appearance. These ancestral tortoises were among the reptiles whose backs were protected by an armor of bony plates. In some species this armor not only completely covered the back but curved down on either side of the body so as to form a protection almost like the lid of a box.

### The Earth's Climate Grows Cooler

So creatures that love warm, wet places flourished and multiplied in early Permian times. It is almost certain that the tropical swampy jungles of the Coal Age continued far into this period over a wide area of the world—in North America, France, Germany, and China. But gradually these watery, humid conditions, ideal for coal formation and for creatures that can live both on land and in the water, gave place to a cooler, drier climate which slowly spread over the Northern Hemisphere. And change of climate brought with it great changes in vegetation, and probably influenced the development of the reptiles who lived on land.

Now there was an enormous continent in Permian times, much of which has since been drowned in the sea. Geologists have been able to piece together the evidence to prove this, and have even given that long-lost continent a name—Gondwana (*gōnd-wā'nā*) land. It probably extended in one unbroken land mass from what is now South Central Africa to the Indian Peninsula and onward by way of the East Indies into Australia. This vast and ancient continent has a fascinating story. The records of the rocks plainly tell that it possessed mountains so high that in spite of their tropical situation they thrust their crests far above the snow line. And winding down their sides were great ice rivers, or glaciers, which must have descended nearly, if not quite, to the sea.

### Rocks That Tell a Tale of Bitter Cold

In fact, there is some reason to suppose that during the Permian period the climate of these equatorial regions was very much colder than it is at the present time; otherwise it is hard to account for the great areas

covered by these glaciers, unless all this land stood at an extraordinarily great height. A kind of local Ice Age seems to have existed in these regions. For we have found rock surfaces which were almost certainly polished and grooved by ice, great boulders that only ice could transport, and other traces of glacial conditions in Cape Colony and the Transvaal, in Central India and Kashmir, in New South Wales, Victoria, and Western Australia. There is more evidence in New Zealand, which did not form part of this great continent of Gondwanaland, but was part of a large island mass lying some distance to the east of it. The records of the rocks show that in Permian times that great island must have been a high, cold land, very different from the New Zealand of to-day.

### When the Antarctic Was Warm and Sunny

As a matter of fact, there are very few important areas of the earth that have not at some time or other gone through an Age of Ice, which has left its record graven upon the rocks. On the other hand, the lands which are coldest to-day have not always been cold. Even the Antarctic cannot always have been buried beneath ice and snow; for the rocks that have been brought back from these regions by the different scientific expeditions contain fossil remains of plant and animal life that could have existed only under tropical or semitropical conditions. Some parts of the world, indeed, seem to have gone through more than one Ice Age; so Antarctica may dream, beneath her mantle of ice and snow, of a distant future that may perhaps bring back warmth and sunshine and a re-awakening of luxuriant life.

But we must return to the map of the world in Permian times. Not only its lost continent, but one of its oceans has been charted and named. This ancient ocean the geologists have called Tethys (*tē'thīs*); it connected the Atlantic and Pacific across Southern Asia and much of Southern Europe, and widely separated North from South America. Geologists consider that to-day the Mediterranean and Caribbean seas and the Gulf of Mexico are the last remaining traces of the Tethys Sea.

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# *The RECORD of the ROCKS*

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## Reading Unit No. 8

### WHEN REPTILES RULED THE WORLD

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

When reptiles ruled the earth during the Mesozoic era, 3-37-39  
Enormous fish-lizards and sea dragons, 3-40  
The terrible dinosaurs, 3-40-42

The flying lizards, 3-42-43  
The first birds with feathers, 3-43  
The first mammals, 3-44  
How chalk cliffs are made in the ocean, 3-44

#### *Things to Think About*

How were the large fish-lizards and dragons able to move through the ocean?  
How did dinosaurs compare with whales in size?  
How intelligent were giant dinosaurs?  
Why was the Tyrannosaurus such

a dangerous dinosaur?  
In what ways were the flying reptiles different from our birds?  
What ancient bird had teeth?  
Why were the first mammals able to get along better than the dinosaurs did?

#### *Picture Hunt*

What dangerous weapons did dinosaurs have for attack and defense? 3-37  
How might Diplodocus fare in a fight with Tyrannosaurus? 3-38  
What was the largest land animal that ever lived? 3-38  
What kind of shell do the eggs of reptiles have? 3-39

How large were the eggs of dinosaurs? 3-39  
Of what use to dinosaurs were their large, heavy bones? 3-40  
What happened to the legs of plesiosaurs? 3-41  
How did Diatryma differ from all other birds? 3-43

#### *Summary Statement*

The Mesozoic era saw the rise of giant reptiles called dinosaurs. Nature let them develop enormously, but forgot to equip them with suitable brains. The same era saw the rise of birds from reptiles. The first birds had

teeth, though none to-day have any. Mammals also appeared at that time. They were successful because they were warm-blooded, gave birth to live offspring, took care of their children, and had better brains than the reptiles.

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by American Museum of Natural History

These two dinosaurs are not playing. They are fighting in good earnest. They were both flesh-eating dinosaurs, the most ferocious of the family. Notice the many cruel teeth, shaped like cones, and the long, sharp claws with which they attacked their brethren,

who were, for the most part, vegetarians and not so well equipped for fighting. These strange reptiles looked very agile, but since they weighed several tons and were covered with thick scales, they can hardly have been so athletic as our picture shows them!

## WHEN REPTILES RULED *the* WORLD

### *The Tale of the Strange Creatures That We Now Meet Only in Nightmares but That Once Stalked the Earth*

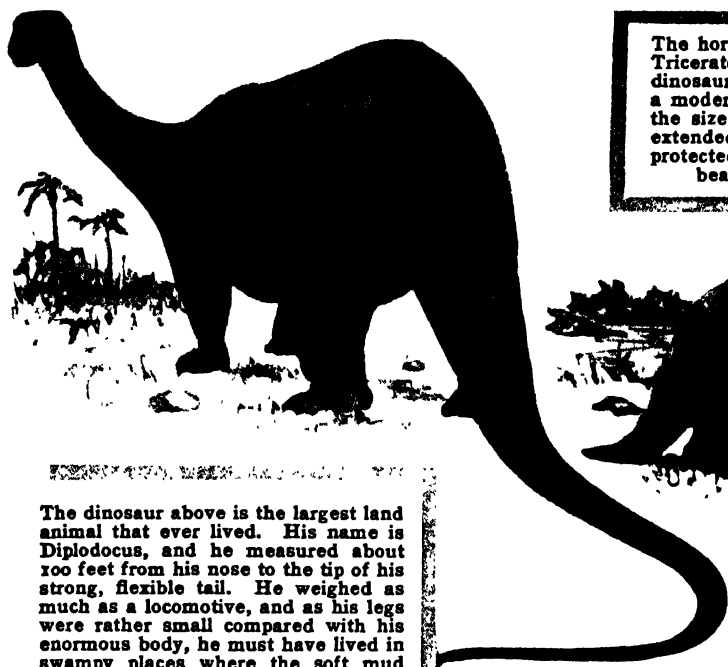
**T**HE process of evolution speeds up as time goes on, and each chapter in each volume of the world's history is more crowded with happenings than the one before. When we open Volume IV, which contains the Mesozoic (mēs'ō-zō'ik) era, or Era of Middle Life, we still have to think in terms of millions of years; but the time scale is not quite so unimaginable as it was for the farthest reaches of the past, when life first began. Yet for all that, the strange and dreamlike creatures of life's Middle Ages, of which we are now to tell, lived a long, long while ago.

Their record is written in three great systems of rocky layers—three chapters in this fourth volume of life's story. The earliest

of these rock systems geologists have named the Triassic (trī-ās'ik), because the rocks naturally group themselves into three divisions. The second they call the Jurassic (jōō-rās'ik), after the Jura (jōō'rā) Mountains in Europe, where many of the rocks of that period are found. The third and latest they call the Cretaceous (krē-tā'shūs), because one of the most important kinds of rock in this system is chalk, for which the Latin word is "creta." Of course each rock system gives its name to the period in which it was formed. We are going to talk about all three of these periods in this story.

The Mesozoic age was the Age of Reptiles. Reptiles were the lords of the earth in those long-gone days. They spread all over the

## THE RECORD OF THE ROCKS



The horned creature below is called Triceratops, and he belongs to the dinosaur family. He was as large as a modern elephant and had a brain the size of a small dog. His skull extended back into a large ruff that protected his neck, and he had a beak instead of front teeth.

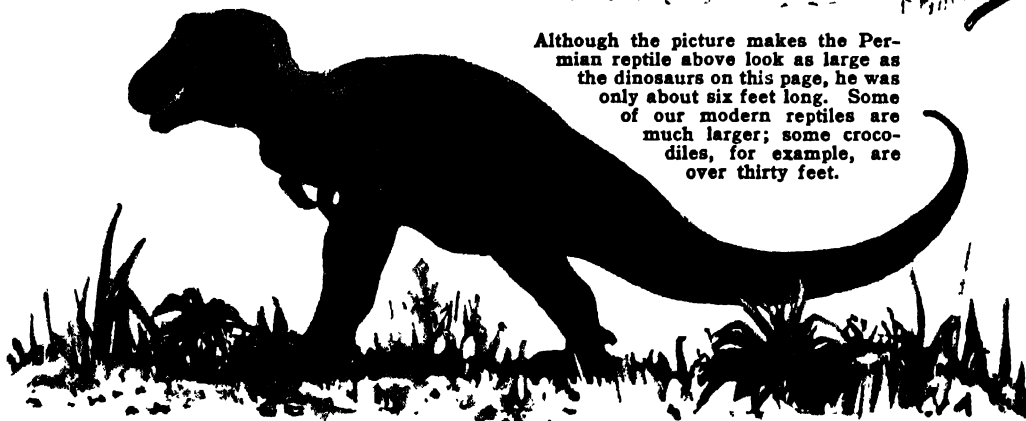


The dinosaur above is the largest land animal that ever lived. His name is Diplodocus, and he measured about 100 feet from his nose to the tip of his strong, flexible tail. He weighed as much as a locomotive, and as his legs were rather small compared with his enormous body, he must have lived in swampy places where the soft mud could help him support his body. He looks very ferocious, but as a matter of fact he was probably as harmless as a cow, moving around very slowly indeed and munching on grasses and leaves. You may think that it would take a tremendous amount of food to keep this great creature alive, but you must remember that he was a cold-blooded animal and that consequently none of the food he ate was needed to keep his body warm. Below is Tyrannosaurus, the largest of the flesh-eating dinosaurs. He walked entirely on his great hind legs, balancing himself with his heavy tail.

All of the animals on this page are dinosaurs which lived during the Mesozoic era—except the one just below, which lived in the Permian Age and which we have already seen in the chapter that tells of the early reptiles.



Although the picture makes the Permian reptile above look as large as the dinosaurs on this page, he was only about six feet long. Some of our modern reptiles are much larger; some crocodiles, for example, are over thirty feet.



Photos by Field Museum

## THE RECORD OF THE ROCKS



Photo by American Museum of Natural History

Many of the reptiles alive to-day lay eggs that are covered with a tough, elastic skin instead of a brittle shell. Some of the dinosaurs laid eggs of this kind. Above you see a "nest" of dinosaur eggs which have been turned to stone; consequently their original form

is preserved. But not all of the dinosaurs laid eggs. Some of them bore their young alive, as mammals do. The eggs are very small in comparison with the creatures that laid them—a great many of the eggs that have been found are only a few inches long.

lands—gigantic beasts, fearsome and grotesque. They swarmed in the rivers, lakes, and seas. Like flying dragons, they dominated the air. Some were the largest land animals that have ever existed, and the sea dragons rivaled the present-day whales in size. The story of their strange, nightmare world has fascinated men ever since it was first revealed, and everybody from the staid geologist to the writer of moving-picture plays delights to imagine what that world must have been like.

### Pigmy Descendants of Ancient Giants

It was a world, of course, which had not wholly changed with the coming of the reptiles. In the earliest part, the Triassic period, the amphibians (ām-fīb'ī-ăn)—or creatures living both on land and in the water—were still flourishing prodigiously, though after a time the great forms died out and only the pigmy salamanders, frogs, and newts were left, much as we have them to-day. The insects were still advancing and increasing

their kinds; we find fossils of butterflies and moths, of bees, wasps, ants, flies, and beetles.

Trees and other plants were growing and developing on a grand scale, so that by the close of the Cretaceous period there were many trees, flowers, and grasses closely related to those that cover mountain and valley to-day. Even in Triassic times there was great change from the days of the coal swamps. Already the giant club mosses, horsetails, and ferns of the Age of Coal were fast dwindling in size and number. At the same time more modern forms were spreading far and wide—forms allied to our monkey-puzzle trees, our great Sequoia firs, our spruces, yews, cypresses, and ginko or maiden-hair-leaved trees. In moist places grew tree ferns, cycads, and many species of ferns, some of them hardly different from the adder's tongue and royal fern of to-day.

And through these forests and in and out of the pools and lagoons splashed and crashed the lords of creation—the giant reptiles. We can see some of their skeletons yet, put to-

## THE RECORD OF THE ROCKS

gether with infinite pains and set up in our museums. What were they like in the days of their glory?

There were enormous water reptiles called the ichthyosaurians (ik'thī-ō-sō'rī-ăn), or fish-lizards, which seem to have been especially numerous in Jurassic times, in the middle of the era. These creatures were sometimes more than twenty-five feet long, and must have looked rather like long-nosed dolphins with immensely large eyes and big flippers. They had smooth skin—judging from the impressions left embedded in the rocks—and instead of legs they had swimming paddles. Their long, slender jaws were well supplied with sharp-pointed teeth. Not a pretty picture, is it?

Then there were the sea dragons, or plesiosaurians (plē'sī-ō-sō'rī-ăn), which were about twenty feet long.

These strange creatures had small heads perched on long, flexible necks, and bloated, lizardlike bodies with long, tapering paddles. The seas and rivers swarmed with ancestral forms of crocodiles, which lived more in the water than do the modern species.

But these water creatures are as nothing to the wonder of the great land reptiles, the dinosaurs (dī'nō-sōr)—whose name comes

from the Greek for "terrible lizard." In parts of Asia and East Africa, and particularly in Western North America, these living nightmares stalked through the forests and across the plains, huge and hideous. Some

of them are supposed to have been 100 feet long! They were the largest land animals that have ever lived, although their size was a matter of length rather than sheer bulk, and it is doubtful if any of them weighed as much as a modern ninety-foot Greenland whale.

For most of their great length was neck and tail. The famous American dinosaur called *Diplodocus* (dī-plōd'ō-kūs), for instance, was over eighty feet long, but comparatively little of his length was body. His great neck served him as a sort of watchtower, for he could raise it thirty feet or so above the ground, and thus look far out over the wide sweep of flat, watery country he frequented.

The enormous creature really needed to be able to see an enemy coming, for he had no armor on his body to protect him and could not have been very agile on his feet. Probably his long tail was his chief weapon, and doubtless that tail could deal terrific blows against an attacking flesh eater.

*Diplodocus* himself lived on plants, and



Photo by Field Museum

This man has to use a small crane to put the top on the dinosaur's thigh bone he is piecing together. As you can see from the picture, one bone from a dinosaur's leg is larger than a man. The animal must have reached more than twice this height at the hips.



## THE RECORD OF THE ROCKS



Photo by Sinclair Oil & Gas Co.

Some of the Mesozoic reptiles took to the sea and some took to the air. Here we have pictures of both. The three plesiosaurs to the left are large reptiles with sleek, fat bodies shaped for swimming. Their legs

have turned into paddles and their tremendously long necks are well adapted for fishing. To the right a mosasaur is poking his crocodile-like head out of the water. Above him is a pterodactyl.

there were many other vegetarian dinosaurs of fantastic size. The brontosaurus (brōn'-tō-sō'rūs)—or "thunder lizard"—measured a full sixty feet from snout to tail tip, and the giant atlantosaurus (ăt-lăn'tō-sō'rūs) or "Atlas lizard"—was longer than that. But these giants all had ridiculously small heads, and brains that were not much larger than a good-sized hen's egg. They were just huge, unmanageable masses of flesh and bone.

So it is no wonder that they fell easy prey to their more agile and more ferocious relatives, such as the tyrannosaurus (tī-răn'ō-

sō'rūs)—or "lordly lizard"—and the ceratosaurus (sēr'a-tō-sō'rūs)—or "horned lizard"—which, though much smaller, were armed with fearful jaws and sharp cutting teeth. These carnivorous, or flesh eating, dinosaurs had relatively stouter bodies. Their forelimbs were short and armed with strong claws for seizing and holding their victims. Their hind legs, which were large and powerful, they used only to carry themselves about. They must have been able to run and leap with great strength and speed.

Yet these fierce creatures must sometimes



Photo by Sinclair Oil & Gas Co.

This is *Stegosaurus*, the stupidest by far of all the dinosaurs. He was about as large as an elephant, and his brain was about one-fiftieth of an elephant's in size. Notice the two rows of bony plates that pro-

have met their match, for many of the vegetarian dinosaurs were clad in stout plated armor that kept them well protected against their enemies. The stegosaurians (stĕg'ô-sô'rĭ-ăn), or plated lizards, for example, were the last word in both ugliness and freakish armor. They were twenty to thirty feet long and some twelve feet high, and carried a series of great upstanding bony plates on their backs and long spines on their tails, while numerous flat plates were embedded in the thick skin of the throat and neck. Truly, walking through those Mesozoic lands would have been like traveling through a nightmare!

### Dragons of the Air

Not all the dinosaurs were gigantic in size. There were, in fact, a large number that were small, agile, almost graceful creatures which ran and leaped with ease. But it is never the less grotesque species that we hear about!

tect his back, and the long sharp spines at the end of his tail. He probably backed up to his enemies and struck at them with his tail. He was a vegetarian and doubtless fought only in self-defense.

Some of these astonishing reptiles had learned to fly. In the rocks of the Jurassic period we find the first fossils of the flying lizards, or pterodactyls (tĕr'ô-dăk'tĭl). They were real dragons of the air, like those that are always flying through fairy tales. For though some of them were no larger than a sparrow, others that lived in the Cretaceous period had a wing-spread of twenty-eight feet. These huge dragonlike creatures had bodies about the size of a heron's, very long heads, and narrow, bony, beaklike jaws usually armed with sharp teeth. From the size of their eye sockets we can tell that they must have had exceptionally large eyes. Their tails were sometimes short and sometimes very long and slender. They flew on big leathery wings not unlike those of a bat, except that the framework was different; for in the pterodactyls the wing membrane was stretched between the immensely lengthened little, or fourth, finger on the outer edge, and

## THE RECORD OF THE ROCKS

the arm, body, and legs on the inner side. The first three fingers remained free as rather weak grasping claws. When on the ground these strange creatures stood firmly on two legs, or on four, and with their wings folded they could walk or crawl about easily. Their flight was probably strong and not unlike that of the great fruit bats of the Tropics to-day.

### The First Birds in the World

But they were not bats, for bats are mammals and suckle their young; and the pterodactyls, being reptiles, were egg layers. And they were not birds; for they did not wear feathers, and you cannot have a bird without feathers, no matter how capable the animal may be of flying and laying eggs.

Yet it is supposed that the birds are descended from the reptiles, and it seems certain that the first of them appeared during the Mesozoic era, the great reptilian age. The earliest fossil remains of a true bird come from the Jurassic rocks. To this first-known bird geologists have given the name

archaeopteryx (är'kê-ôp'tēr-iks), or "ancient flyer," for it had well-formed wings not unlike those of a modern bird. But although it had feathers and was a true bird, it was still in some ways like its reptilian ancestors. Its head had no horny beak, but instead it had jaws set with small teeth. Its body ended in a long slender tail like a lizard's, but to every joint was attached a pair of quill feathers—it was, in fact, a lizard's tail that had sprouted feathers. This fascinating creature was about the size of a big crow.

This is the only bird we have found that dates earlier than the very last of

This is the skeleton of the giant Eocene bird, *Diatryma*. He was seven feet tall—not quite so tall as an ostrich, but much heavier. He was a walking and running bird, as you can see from the fact that he has no wings. His head and beak were tremendously large, and he had long, hairlike feathers.

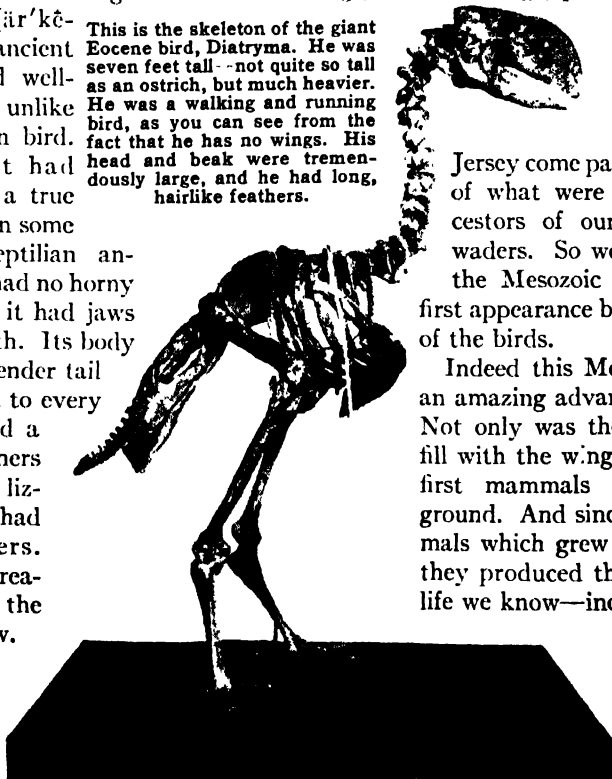


Photo by American Museum of Natural History

the Mesozoic. But the race must have flourished and developed well enough, for the next fossils, found in Upper Cretaceous rocks in Kansas, show several species of birds already a long way toward modern forms. One of these, called *hesperornis* (hēs'pēr-ôr'nīs), or "bird of the West," was very large, standing fully six feet in height. But its wing bones were very much reduced in size, and it had completely lost the power of flight! So, since this ancient feathered creature was a true bird, we can see that flying is not the most important thing about a bird after all. *Hesperornis*, as a matter of fact, probably did not need to fly, for the structure of its skeleton makes us think that it must have been an expert diver and able to live entirely in and around the water.

### The Strange "Fish Bird"

Other bird fossils turn up from the Cretaceous rocks. From the same layers in Kansas come the bones of a smaller bird called *ichthyornis* (ik'thī-ôr'nīs), or "fish bird," whose legs, feet, and large, powerful wings are all

much like those of the birds of to-day. From the greensand fossil beds of New

Jersey come parts of the skeletons of what were probably the ancestors of our cormorants and waders. So we can be sure that the Mesozoic saw not only the first appearance but a great advance of the birds.

Indeed this Mesozoic period saw an amazing advance of life on land. Not only was the air beginning to fill with the wings of birds, but the first mammals appeared on the ground. And since it was the mammals which grew and evolved until they produced the highest forms of life we know—including ourselves—their appearance was tremendously important.

We find the first traces of them even earlier

## THE RECORD OF THE ROCKS

than the first traces of the birds, in the Triassic, the earliest period of the era. So they were the first warm-blooded animals—for fish and amphibians and reptiles have cold blood, but the blood of birds and mammals is warm. These earliest mammals were very small and primitive creatures. It is rather hard to make out just what they looked like, for all we have is odds and ends of bones, jaws, and teeth. But they may have carried their young about in a pouch, as do the modern kangaroos. It is supposed that the kangaroo rat of Australia is their nearest kin in the modern world.

These little first mammals were probably spry and active—as they would certainly need to be to keep out of the way of the flesh-eating dinosaurs and flying dragons and all their other queer reptilian enemies. They could probably outwit the big reptiles, as they had much better brains; it is supposed, in fact, that small as they were they had brains bigger than those of the biggest reptiles. Furthermore, the baby mammals would have a much better chance to grow up and use their brains. For while a reptile mother lays her eggs and leaves the young to look out for themselves, a mammal mother suckles her young, and so at least for a time tries to protect them. And that was something altogether new in the world.

So we have read in the great book of three thrilling things that slowly came to pass in life's Middle Ages: the reptiles rose to an astonishing power that we should never guess from their state in the world to-day, and two new races, the birds and the mammals, came into being, the second with enormous promise for the future. All this happened on land.

But what of animal life in the sea during all these ages? Had it come to a pause? By no means. To be sure, the sea's greatest part in the story of life was over, but the pageant of sea life went on just the same. And at least one important and fascinating thing going on in the later Mesozoic left its print on the face of the earth to-day. That was the building of the chalk cliffs, from which the Cretaceous period is named.

For chalk is almost entirely made up of

the shells and fragments of microscopic marine animals called Foraminifera (fō-rām'ī-nīf'ēr-ā). In the midst of the chalk are embedded fossils of starfishes, sea urchins, mollusks, corals, sponges, bony fishes, crabs, and other sea creatures. But just now it is the Foraminifera themselves of which we want to tell. They belong to the simplest forms of life, the protozoa (prō'tō-zō'ā), which have come down through the long geological ages with but little change in size, habit, or aspect. Each one is a mere tiny speck of living stuff, but it can draw the lime out of the sea water and form it into an exquisite, infinitely fragile shell around itself. This shell is so small that its beauty can be seen only with the help of a high-powered microscope—it takes more than a million such shells to make a cubic inch of chalk. Yet so many of these Foraminifera have lived and labored and died that some of the Cretaceous chalk layers are thousands of feet thick! So the next time you write something on a blackboard, remember that you are writing with the skeletons of millions of ancient living things. And if you ever get a chance to look at the white chalk cliffs of England towering against the sky, try to imagine how long it took the Foraminifera to deposit all that chalk on the floor of an ancient sea.

And you must remember, too, that the same sort of thing is going on over parts of the ocean's floor to-day. When the transatlantic cables were laid, very deep soundings had to be made in the open sea. From the results of those soundings, and from samples of the living organisms from the surface water, scientists have discovered that just such chalk deposits are now forming out in the Atlantic at a depth of some 12,000 feet. Just as in Cretaceous times, the Foraminifera live and multiply in the surface waters, and when they die their tiny shells sink to the bottom and there accumulate as a grayish mud or ooze. For all we know, in some far future this ooze will harden and be heaved out of the sea as the white chalk cliffs of some new continent.

And so the ancient rhythm goes on. Foraminifera die and chalk cliffs rise—gigantic reptiles rise and disappear from the earth.

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# *The RECORD of the ROCKS*

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## Reading Unit No. 9

### THE RISE OF THE MAMMALS

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Great gaps in the record of the rocks, 3-45-49  
The era of new life—"modern times," 3-51  
Changes in animal life and climate in the Tertiary period, 3-51  
What the first horse looked like, 3-51

When the elephant got his tusks, 3-52, 55-56  
The rise of flesh eaters, 3-52  
When whales began to swim, 3-52  
What happened to the insects, 3-53  
The coming of man, 3-57

#### *Things to Think About*

Why are there a great many "missing links"?  
How did sea shells get to the top of the Alps?  
What modern birds lived in Oligocene times?  
What led to the development of

insects?  
What protection has a plant-eating animal against a ferocious flesh eater?  
Upon what evidence do we base our knowledge concerning the earliest kind of man?

#### *Picture Hunt*

What gigantic mammal once lived in the United States? How did it differ from its African relative of to-day? 3-48  
What makes old asphalt pits a fine place for fossil remains? 3-49  
How many toes did the first horse

have? 3-50  
What killed off our North American rhinoceroses? 3-46  
What bodily structure gave rise to the tusks in an elephant? 3-54  
What dangerous enemy did the woolly mammoth have? 3-55

#### *Summary Statement*

Dinosaurs died out suddenly and were replaced by mammals. Birds, insects and plants that are still with us to-day existed in the Cenozoic period. The earliest horses were five-toed and as small as dogs. To-day horses are tall

and walk on a single toenail, the hoof. The elephant's trunk gradually grew longer and he lost one pair of tusks. Finally, as the world's climate changed, the apes and early man developed.

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You have already seen the Miocene ancestors of this Pliocene rhinoceros. Except for his stumpy legs he is very much like our modern animal. It is very hard to imagine that these creatures were quite common in

North America for many thousands of years. They seem to have originated there, and they stayed there until the great ice sheets began to creep down during the Ice Age, when the climate grew too cold for them.



Photos by American Museum of Natural History

These giant pigs lived in North America in the Oligocene. They were ferocious creatures, probably much

like our wild boars, who are their descendants. They lived on roots dug up with their tusks.

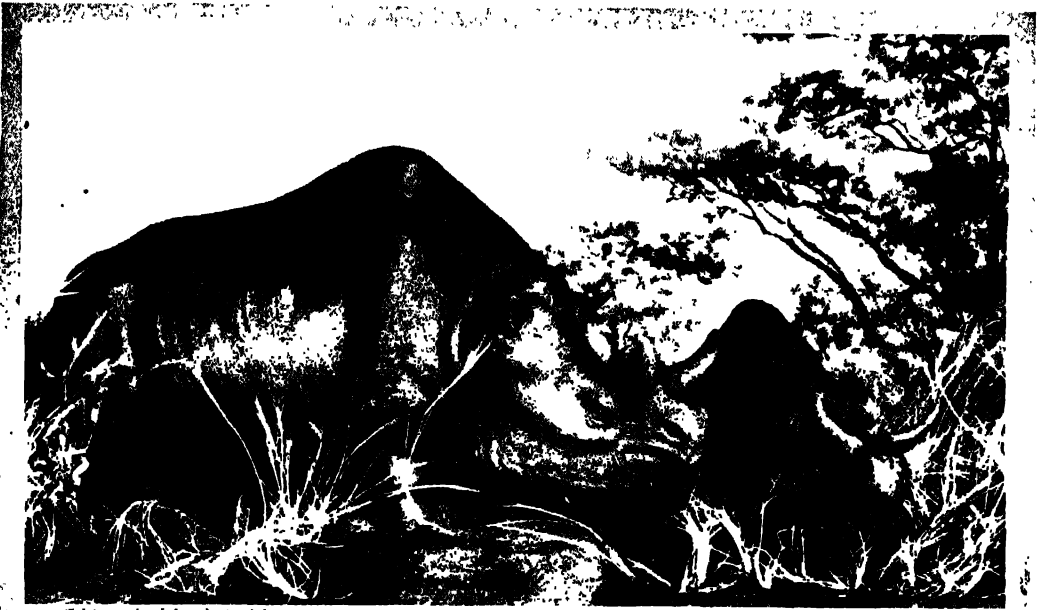


Photo by East Museum

These early Cenozoic mammals are the ancestors of our present-day rhinoceroses and tapirs. From small horny knobs on the ends of their noses they developed

great, blunt horns which were still getting larger when these animals died out in the Oligocene. Like their descendants they were vegetarians.

## The RISE of the MAMMALS

*Here You May Read of That Great Period in the Earth's History  
When Mammals Rose to Their Present Importance—a  
Period That Was Brought to a Dramatic Close*

**H**AVE you ever started an exciting story in some old and battered book, and suddenly come to a place where a whole chapter is missing? Frantically you look about for those lost pages, but you cannot find them. Then you plunge into the story again after the break and try desperately to piece out from the later chapters what must have happened in the one that is lost. But you can never quite make out just how this or that in the later part of the story could have come about—and you cannot get over having an unsatisfied feeling, as if you had been cheated.

That is much the way geologists feel when they turn from the rocks that tell the story of the Mesozoic (mēs'ō-zō'ik), or Middle Life, era in the history of the earth's development, to the rocks of the Cenozoic (sēn'ō-

zō'ik) period, or the Era of New Life. For it is clear that there is a long break in the story. Such astonishing things have happened by the time when this new volume opens! Practically all the giant reptiles—the huge and grotesque dinosaurs (dī'nō-sōr) and ichthyosaurs (ik'thī-ō-sōr') and plesiosaurs (plē'sī-ō-sōr'), lords of land and water—have disappeared. There are no more fossils of them to be found. Instead, other forms of life have become dominant. It is very puzzling, for such things do not happen without a cause. How, when, why? we ask. But the rocks do not answer.

And there does not seem to be much chance that the rocks will ever answer. For nowhere in the world has anybody been able to discover a place where the last of the chalk formed at the bottom of the seas in Creta-

## THE RECORD OF THE ROCKS



These are some of the typical animals that lived in North America in the late Miocene. To the left are stumpy-legged rhinoceroses and to the right are masto-

dons that have four tusks. Later the lower tusks ceased to form, and our present-day elephants have only the two great upper tusks.



These are some of the animals that lived in North America in the early Miocene. In the distance are

giraffe camels. In the center are giant pigs. To the right are horselike clawed animals.

ceous (krê-tā'shūs) times, at the close of the Mesozoic period, passes gradually into the layers of the earliest Cenozoic. Sometimes a series of layers looks as though it ought to prove continuous, but when it is closely examined the same gap appears: when a certain level is reached the hitherto fairly numerous remains of the dinosaurs abruptly cease, as if the big reptiles had suddenly all died out at once. Then there will be layer after layer of rock with almost no fossils at all—rocks which must have been forming from sediment through vast periods of time. Then the fossils will begin again, as suddenly as they stopped—but how different they are now!

Old forms are gone, new forms have appeared. From here onward to the present there is no great break in the record; and naturally, the nearer we approach to our own times, the more fossils there are and the more familiar they look. But what happened while those barren layers were forming we shall probably never know.

It does not seem likely that it was a change in climate that killed the dinosaurs, for plant life would have been the first to be affected by anything of that sort, and the plants continued to flourish and increase. Nor did the other kinds of reptiles die out. The crocodiles and turtles have held their own down



## THE RECORD OF THE ROCKS



Photo by Field Museum

To the left are ancestors of our modern sloth. They are giant sloths that measured six or eight feet in length. To the right are very early giant ancestors of our present-day armadillos.



This picture shows a scene where many tragedies took place. Large animals who came to drink the waters on the surface of a treacherous asphalt pit sank down in the sticky material. Condors, giant wolves, and

tigers who came to feast on the trapped bodies were engulfed, too. Their bones were perfectly preserved in the asphalt; so scientists have been able to reconstruct these animals as you see them above.

to our times, and during the mysterious interval snakes and lizards increased in variety and number. Perhaps the disappearance of the gigantic reptiles was due to the littleness of their brains; at all events, the dinosaurs died out. When the record begins again we are no longer in the Age of Reptiles, but in the Age of Mammals.

Whether or not climate had anything to do with the extinction of the dinosaurs, it is certain that in the Cenozoic era it began to

change and that the changes had an enormous effect on the story of life. At the beginning of the era the whole world seems to have enjoyed a mild and even temperature, for the fossils tell of luxuriant vegetation in the polar lands. But as the era wore on, apparently the earth grew hotter, for tropical and subtropical plants grew over much of the land. Then slowly, in advancing and retreating waves, came on a time of cold, until toward the end of the era we have come to the Age

## THE RECORD OF THE ROCKS



Photo by American Museum of Natural History

These small, gazellelike creatures which lived in the Eocene are our earliest known horses. They were about the size of a small dog. From these primitive forms we have a whole series of animals that lead up to our modern horses. Gradually, as they developed through the ages, they became larger, and many other

changes took place. Their legs grew longer, and, to keep pace with their legs, their necks grew longer so that they could reach the grass which was their food. They developed from a five-toed ancestor, but they have gradually lost certain toes, so that the hoof of the modern horse is nothing but the end of one toe.



Photo by American Museum of Natural History

You have already seen the descendants of this animal—on the first page of this chapter. This very early

member of the family has not yet developed the horns we spoke of, nor is he so large.

## THE RECORD OF THE ROCKS

of Ice, when great areas of the Northern Hemisphere lay deep buried under ice and snow. But of the Glacial or Ice Age we shall tell in a later story.

### The Era of New Life

The present story is to be about the first four chapters in that volume of the Book of the Rocks which tells of the Cenozoic, the Era of New Life. Together they make up the division of the Cenozoic often called the Tertiary (tûr'shî-â-rî), or Third, period of life. In this series of names the whole Paleozoic (pā'lē-ō-zō'îk) would be called the Primary, and the Mesozoic, or Age of Reptiles, the Secondary. The Tertiary story will bring us so comparatively near our own times that at the end we can begin to count years by tens of thousands instead of by millions, as before.

These first four chapters of the Cenozoic volume have been given names which tell in what proportion the fossils of extinct and living species are found in the rocks. Thus the earliest period is called Eocene (ē'ō-sēn), which means "dawn of recent life"; the second is Oligocene (ôl'î-gō-sēn'), or "few recent," which indicates that there are in its rocks only a few fossils of forms now alive; the third is Miocene (mî'ō-sēn), or "not so many recent," which means that there are still more extinct forms than living ones; and the fourth is Pliocene (plî'ō-sēn), or "more recent," which means that the living forms are more numerous than the extinct ones. Suppose we read a little in the rock record of each of these periods in turn.

### The Genial Warmth of the New Era

The earth's climate seems to have been still pretty warm in Eocene times, at the beginning of the new era. For we find many fossils of plants which live to-day in sub-tropical lands—palms, cinnamons, figs, magnolias, and tree ferns. The sea life too was somewhat like that in tropical seas to-day. The fish take on a modern appearance; most of the old species have died out, and new ones with complete bony skeletons like modern fish have taken their places.

As in the Cretaceous period just before this, an enormous amount of limestone rock

was being formed on the sea floor by those tiny, busy creatures, the Foraminifera (fô-rām'î-nîf'ēr-â). At a later period these limestones were to be heaved up from the bottom of the sea on the shoulders of enormous mountain ranges; and to-day, 20,000 feet above the sea in Tibet, and in the Alps 10,000 feet above the sea, we may see great masses of limestone full of the disklike shells of these tiny animals that lived in the water. The shells vary in size from mere specks to the bigness of a penny, and because of their coinlike shape are called nummulites (nûm'û-lit). The descendants of these Eocene organisms still abound in parts of the Pacific.

On land, the birds and mammals made great progress during the Eocene. The birds flourished and grew in numbers, and became less like reptiles and more like modern birds. The mammals were doing well too, but they were still mostly small and not much like any living species.

### Some of Nature's Discarded Experiments

There were a good many puzzling mammals in this period which are rather like experiments that did not work. They seem to combine the characteristics of more than one of the great groups of mammals as we know them now, and so are sometimes spoken of as "composite types," or "omnibus animals." Thus there were creatures which were partly like pouch bearers—such as the kangaroo—and partly like flesh eaters. Others come between the pig tribe and the flesh eaters, still others between the tapirs and the horses. There is one which seems to be related to both the plant eaters and the flesh eaters.

On the other hand, if we could have been about the world in those days, we should have seen the ancestors of many familiar modern beasts. Not that we should have been able to recognize them! The first creature, for instance, which is supposed to be the direct ancestor of the horse appeared in the Eocene. It was a little beast not much larger than a fox terrier, slender in build, with four toes on each front foot and three toes on each hind one.

The ancestors of the rhinoceros were already living in those days, and so were those

## THE RECORD OF THE ROCKS

of the elephant. The elephants have been dug up from near Lake Mocris in the Fayum (fī'yōōm') Desert of Egypt. They stood only about three feet high at the shoulder, had fairly long necks and small sloping skulls, and probably in late life had a short snout. Certain of the teeth in the upper jaw were developed into little tusks, and the lower jaw had a pair of tusklike teeth. They were not very much like our elephants as yet, but that snout and those tusks will grow. They were sturdy little beasts, and had good brains for their size. Later in the Eocene a larger, more advanced type roamed through the same regions.

### Ancestors of Modern Animals

In the forests of Eocene times, certain small animals with very large eyes prowled about among the branches, probably at night, in search of the fruits and insects which formed their natural food. These were the ancestors of the modern lemurs.

Then there was the *Arsinoitherium* (ār'sī-noi-thē'rī-ūm)—we must not fail to mention that odd beast! No one has been able to discover who its ancestors were, and it became extinct at the end of the Eocene and so has no descendants. It is named after *Arsinoë* (ār-sīn'ō-ē), a famous queen of ancient Egypt—but by no means because it is supposed to have been clever or beautiful! The bones were found in the neighborhood of one of Queen *Arsinoë's* palaces, and that explains the name. The creature was as big as a good-sized rhinoceros and looked a bit like one of those ugly beasts. It had a pair of small horns on its thick skull, and its great long nose was armed with a second pair of horns of quite formidable size. When we think of having such creatures about, we may be just as content that we cannot roam about the Eocene world!

### The Terrible Saber-toothed Cats

In fact, the more the mammals advance the more dangerous life becomes for everybody else. The next period, the Oligocene, saw the great carnivores (kār'nī-vōr), or "flesh eaters," flourishing and advancing toward the types we know. The ancestors of modern wolves appear, and of weasels,

and the various members of the tribe of cats. The first saber-toothed cats were abroad in the world, armed with their long, terrible canine teeth curved like a scimitar. Some of these creatures were small and some large; some were fleet and slim, others more heavily built. But they all had those murderous teeth. There was also a large-headed beast called a *hyaenodon* (hī-ēn'ō-dōn), because it resembled a hyena. Sometimes it was no larger than a small fox, and at other times it might be as big as a large wolf.

Yet in spite of the beasts of prey, many new forms of plant-eating mammals roamed the world in Oligocene times. There were large and small piglike creatures grubbing about in the forest glades, and small creatures -- much like deer and gazelles which resembled the pretty little deerlike chevrotains (shēv'rō-tān) that live in Africa to-day. The horses were now as large as fox hounds, and their feet were developing toward the hoof they wear to-day.

### The Fearsome-looking Brontops

One strange rhinoceroslike beast that lived in Oligocene times had a sinister look which may not have revealed its real nature at all. This was the *Brontops* (brōn'wōps), a heavily-built animal with a pair of horns on its nose--not one in front of the other, as in our modern two-horned rhinoceros, but planted side by side across its broad nose. They were probably used chiefly for pushing a way through the thick undergrowth, and the creature may not have been nearly so fierce as it looked. In what is now the Gobi Desert in Central Asia, there roamed a gigantic rhinoceroslike beast as large as an elephant, but with no horn on its snout.

In Eocene and Oligocene days, too, lived the ancestors of the whales. Very early some of the mammals seem to have taken to the water. For whales, we must remember, are not fish at all, but warm-blooded creatures which belong to the great group of mammals, along with horses and tigers and dogs and the other beasts of the land.

The Oligocene was a great time for the birds. In those days most of the modern species came into being. Along the seashore and on the cliffs cormorants, puffins, gulls,

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## THE RECORD OF THE ROCKS

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by An of Natural History

Could you ever guess that the animal to the left is a rhinoceros? He is one of the very earliest of the tribe, belonging to a branch that never took to the

water. Unlike his swamp-loving relatives, he was probably a grazing animal of the plains, who depended upon his long, swift legs for safety.

and gannets had their homes. Redshanks, plover, cranes, ibises, flamingos, and pelicans haunted the marshes and tidal pools. Inland on the heaths and plains and among the hills, buzzards, kites, eagles, owls, and other birds of prey hunted and bred. And from the woodlands came the chatter of parrots, the harsh cries of pheasants, crows, and shrikes, and the softer notes of many singing birds.

### Entombed in Amber

With the ever increasing wealth of vegetation, it was only natural that the insects should also prosper and increase. By Oligocene times bees were busy among the flowers, butterflies were on the wing, and indeed all the different orders of insects we know to-day were about in the world. Many of their forms have come down to us beautifully preserved, entombed in transparent amber; for amber is really the fossilized gum of certain trees that flourished in those far-off days—as we have explained on another page of these books.

All through the Oligocene the same tropical and semitropical plants flourished as flourished in Eocene times, and so we know that

the climate was still warm. But when we pass on to Miocene times, we discover that the cooling process is getting under way. There are more leaves torn out of the rock record here, but we have enough to make that much clear. By the end of this period palms and other tropical plants had disappeared from Central Europe, and in their stead were forests of trees that thrive in cooler climates—largely conifers (*kō'nī-fēr*), or cone-bearing trees and others of the sort that lose their leaves regularly once a year. An enormous region which would include modern Greenland, Iceland, Spitsbergen, Alaska, and the greater part of Japan, had become the home of vast forests in which oaks, conifers, poplars, and hazels grew in great numbers. So the woods and hillsides must have begun to bear a more modern look.

### The Coming of the Apes

The great event of the Miocene period was the appearance of the first ancestral apes. The fossils of these creatures, which seem to be the forerunners of our gibbons, chimpanzees, and baboons, have been found



Photo by American Museum of Natural History

Simple people have invented legends to explain how the elephant got his trunk, but the explanation science gives is just as fascinating as any myth. The elephant did not suddenly develop a trunk overnight, but took many millions of years to grow it. At 1 is the earliest elephant known. He was about the size of a pig, and lived in North Africa in the upper Eocene. No. 2 lived in the Oligocene. He is beginning to look more like

an elephant. His upper lip and nostrils, L and N, are growing longer and will some day become his trunk. His upper and lower front teeth, T, are also getting longer. At 3 we have the modern Indian elephant with his long curling trunk—upper lip and nostrils combined. No one would guess that his valuable ivory tusks are upper front teeth that have grown very large. His lower tusks have disappeared.

in certain Miocene rocks in Europe. The saber-toothed carnivores greatly increased during these times, growing ever bigger and more numerous. One of them was a tigerlike beast armed with fearsome long, curved, and powerful canine teeth. This is the famous saber-toothed tiger, which was still roaming the world in the infancy of man. There were wolflike beasts, too, in Oligocene days, and agile martens and polecats.

#### The Survival of the Fittest

The carnivores, in fact, were getting so dangerous that we can see the results of their power on the gentler beasts. If the plant eaters did not possess some way to protect themselves they were likely to die out, and

many species did in fact become extinct. Those Eocene rhinoceroses whose snouts had no horns were destroyed, though their armed relatives have survived till this day. Some of the deer began to have simple but useful horns on their heads.

#### Horse, Elephant, and Camel

In North America ancestors of our camels, llamas, and tapirs were developing. The horses had reached the size of a Shetland pony, and their feet were becoming ever more adapted to speed. One of the Miocene elephants stood six feet high or more, and possessed lower jaws of enormous length; these formed a protecting support for his trunk. He was furnished with strong tusks for dig-

## THE RECORD OF THE ROCKS



This is the giant saber-toothed tiger of the Ice Age. He gets his name from the great saberlike teeth with which he ripped the prey he had brought down with

his strong claws. He was about the size of a modern lion or tiger, but he was much more powerfully built, with massive legs and strong, rippling muscles.



Photos by American Museum of Natural History

This is the woolly mammoth who roamed the cool world into which man was born. Behind him is one of our early ancestors, who is signaling to his friends

ging up roots, and besides these he had a pair of tusks that grew out from his upper jaw and curved slightly downward. Except for the lower jaw, these beasts must have

that he has found the herd of mammoths whose tracks he has been following in the snow. The cave men drew very lifelike pictures of these beasts.

looked much like modern elephants. Their natural home was Europe, but they wandered far, even across the land bridge of those ancient days into North America.

## THE RECORD OF THE ROCKS



Photo by Field Museum

The cave men have left us carvings of these ferocious creatures, and probably lived in constant dread of

them, for the Pleistocene bears lived in caves just as our Pleistocene ancestors did.

Nature seems to have experimented a good deal with elephants, just as with rhinoceroses. For instance, in the Miocene and Pliocene there wandered over Europe, Asia, and Africa a remarkable race of elephantlike beasts called *dinotheres* (dī'nô-thēr). They had long, sloping faces and downward-curved, elongated lower jaws ending in an extraordinary pair of powerful, saber-shaped tusks, which were doubtless used as weapons of defense as well as for digging up roots.

### Strange Beasts of South America

South America at this period was not connected with North America at all; the map of the world was still very different from the map to-day. That explains why South American animals are not at all like those of North America. In the southern continent not carnivores but herbivores (hūr'bi-vör), plant eaters, became dominant. There were

ground sloths of various sizes—small at first, but developing into giant forms that lasted until times which to a geologist seem recent. There were armadillos, which increased in size and in their equipment of bony armor until they must have been most extraordinary-looking beasts. These old species are now extinct, but there are plenty of armadillos still alive. In Southern Patagonia geologists have found fossils of queer birds called *Stereornithes* (stēr'ê-ôr'nî-thēz), probably related to the cranes. One of these was an immense long-legged bird with a head larger than that of a horse and a most wicked-looking beak for capturing its prey. It was unable to fly at all, and probably lived on fishes and lizards, which it caught with its wicked beak.

There is not much to say about the reptiles of Miocene times, except that they were not so very different from those we know to-day.



## THE RECORD OF THE ROCKS

There were giant land tortoises, alligator terrapins in the lakes and rivers, and turtles rather like modern hawksbills swimming in the seas. Lizards and snakes of modern type were developing, and for the first time the fossil skeletons of poisonous snakes appear.

And so we come to the Pliocene period, with which we are going to end this story—for a very good reason which you will discover in a few moments. By this time the temperature change was becoming very marked; and vast movements taking place in the earth's crust at this time, helped the change along. Huge mountain ranges were slowly heaving themselves up in various parts of the world, coast lines were changing, everything was disturbed. The cooling of the air is very clearly recorded in the rocks by the change in the plant fossils we find. The once-dominant tropical and subtropical species disappear, and are replaced by harder forms like those known in northern countries to-day.

The animals, particularly the mammals, continue to advance. In European rocks of this period we find fossils of cats, hyenas, wolves, and civets; of the three-toed horse; of deer, antelopes, two-horned rhinoceroses, early elephants, and the ancestors of giraffes, apes, monkeys, and swine. In India appear the first oxen and buffaloes, the true elephants and hippopotamuses, the bears, and the most ancient of the Old World camels.

But we are going to stop this story here and save the rest for another time. It is not the coming of the cold and ice—though that is important—which puts an end at this point to what we call the Age of Mammals. It is the fact that in the Pliocene rocks we have found what many learned men believe

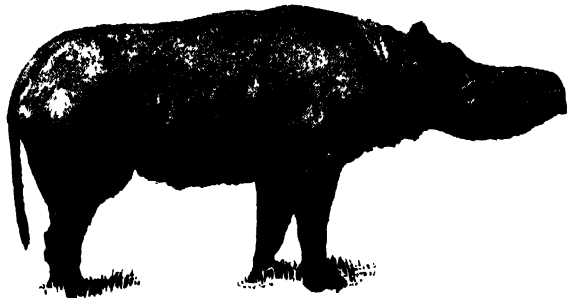
to be the first traces of man—though other scholars think the remains are not so old.

This fossil man was dug up at Piltdown, in Sussex, England, not very long ago. So he is called the Piltdown Man—or sometimes, more poetically, *Eoanthropus* (ē'ō-ān'-thrō-pūs), the "Dawn Man." When he was alive, in that far dawn of the human story, he must have roamed the fringes of the forests of the Sussex Weald and climbed the gracious slopes of the South Downs, higher then than now. The world about him was a world of change and confusion; early forms of both plant and animal life were fast dying out, subtropical species were retreating before the advancing cold, and new and harder species were taking their places. But of course he would know nothing of these things.

He was still very brutish. Yet he had a brain case large enough to make us suppose that he had true human intelligence, though of course of a very simple and primitive sort. We really know almost nothing about his way of life. We think, however, that he had learned to use tools. He had probably even learned a certain rude skill in chipping and roughly shaping flints to use as tools, for such simply worked flints, called *coliths* (ē'ō-līth), have been found in considerable numbers in the Pliocene rocks of England and France. The whole story of early man is told on other pages of these books.

Now: just when or where or how this new race had come into the world we do not know—perhaps shall never know. At present we are not even certain that it appeared at just this time. It may have been born in the next, or Pleistocene, Age. But we do know that with its coming a new age dawned in the history of the earth.

This interesting relative of the rhinoceroses roamed over parts of America in Oligocene times, but is now extinct. We call him *Caenopus*.



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# *The RECORD of the ROCKS*

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## Reading Unit No. 10

### MAN COMES INTO HIS OWN

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How long has man been on the earth? 3-50  
A world half covered with ice, 3-60  
Why birds began to migrate, 3-61

How Europe was once joined to Africa, 3-61  
How North America was once joined to Asia, 3-61  
The Age of Man after the retreat of the ice, 3-64

#### *Things to Think About*

Why is man said to be a new-comer in this world?  
How much of our world was once blanketed with immense glaciers?  
What effect did the ice have on

animals and plants in Africa, South America, and New Zealand?

What made it possible for many animals to escape to Africa from Europe?

#### *Picture Hunt*

What conditions may have been the cause of ice ages? 3-59  
What special handicap did the Irish elk have when he was chased through the woods? 3-61  
Where do rivers carry sand and gravel? 3-62  
Why are the simpler types of

fossils found in the lower layers of rock? 3-62  
How are new islands born? 3-63  
Why does the earth's crust wrinkle? 3-63  
What animal was the last to appear on earth? 3-64

#### *Leisure-time Activities*

PROJECT NO. 1: Construct a mound of beach sand and let water trickle over the top. Let the sand and water fall into a basin to show how erosion removes material from hills, 3-62

PROJECT NO. 2: Construct a large chart showing the important geologic eras. Illustrate each group of animals with suitable pictures, 3-64

#### *Summary Statement*

The coming of the Ice Age destroyed countless forms of plant and animal life. Land bridges helped some animals to escape from Europe to Africa, and from North America to Asia. Big

mountain ranges were formed and other land sank beneath the waves. In the midst of this period, man developed, and began his slow growth into the civilized human being of to-day.

## THE RECORD OF THE ROCKS



Photo by Govt. of New Zealand

There are two important kinds of glacier: mountain glaciers, such as you see above, and continental glaciers, like the great ice sheets that moved down over North America and Europe during the Pleistocene Age and still cover most of Greenland to-day. In any high mountains the snow accumulates without melting and forms rivers of ice which flow down and melt in the

valleys. But continental glaciers are on a much grander scale. If the temperature of the earth's surface were to fall just a few degrees, we should have another Ice Age. Great sheets of ice—continental glaciers—would spread over great areas, covering mountains and valleys. But if our temperature were raised ever so little, Greenland's ice would melt.

## MAN COMES *into* HIS OWN

*Crowded by Advancing Glaciers and Hunted by the Beasts, Man Climbed Steadily Upward During the Latest Great Period in the History of Our Earth*

**S**UPPOSE that the geologists are right who tell us that the oldest known rocks are some two billion years old, and that life has been abundant on the earth for some five hundred million years. That makes man seem very young indeed, since he appears to have lived on earth well under a million years and perhaps has not been a really self-conscious, social being for more than thirty thousand years. Yet since we are human beings ourselves that little fraction of time—that mere ticking of the second hand on time's great clock—seems to us vastly more important than all that went before. So the latest chapter in the great record of the rocks, the chapter which tells of the Quaternary (kwâ-tûr'nâ-rî), or Fourth, period, fascinates us because it tells of the

conditions under which the first men lived and struggled into true humanity.

This chapter is set down in two systems of rock which follow in order after the Pliocene (pli'ô-sên), the last of the Tertiary (tûr'shî-â-rî) systems, of which we have told on an earlier page. The first system is called Pleistocene (plis'tô-sên), which means "much recent life," and indicates that the Pleistocene fossils include a great many forms still found on the earth. This period covers the coming and progress of the great Ice Age. The second Quaternary period is called Recent, and covers all that has happened since the Ice Age ended. It is not nearly so long as the Pleistocene.

At the close of the Pliocene period and the beginning of the Pleistocene, so the rock

## THE RECORD OF THE ROCKS

records tell us, the earth continued to move with restless volcanic energy, forming new continental shore lines, heaving up tremendous mountain ranges. And all the time the cold kept advancing. In the northern regions, vast high areas in Scandinavia became the gathering ground for immense snowfields from which issued huge glaciers that slowly forced their way down through the mountain passes to the valleys and open plains. In parts of Asia great glaciers were traveling from the Ural Mountains eastward, and the mighty Himalayas formed another center from which glaciers spread to the south and west. More than half the continent of North America, from the Atlantic to the Pacific, lay buried beneath thick ice. Through many thousands of years these conditions continued, and the ice sheets and glaciers spread until not less than eight million square miles of country were buried beneath their mantle of deadly cold. It was perpetual winter.

But we must not suppose that the whole Pleistocene was one uninterrupted Age of Ice. For it is clear that the cold kept advancing and retreating in vastly slow pulsations. The ice cap would creep down from the northern regions, driving all life before it—then as deliberately it would retreat again with the return of warmer times. Geologists have named the milder times between the advances of the ice interglacial (in'tēr-glā'shāl) epochs, and so they speak of the first glacial epoch or the third interglacial epoch, or the like. It is supposed that in some parts of the world there were no less than six separate advances of the ice.

### A Frozen World

We do not know why all this happened. Many clever theories have been put forward to explain it, but none of them does so very successfully. We only know that it did hap-

pen, and that the record of how these new conditions affected the development of living things is written in the rocks.

For of course a world half covered with arctic cold was very different from the mild subtropical world in which life had so far developed, and the wonder is that life survived at all in the colder regions. Great numbers of species of course were caught and wiped out by the cold. Those which escaped did so by flight. The cold advanced very gradually, as we have said, and the animals at least, if not the plants, could migrate before it toward warmer regions.

For at no time was the whole surface of the earth ice-bound. There was not a great deal of ice in Africa. There would be glaciers in the mountains, as indeed there still are on some of the highest peaks; in Pleistocene times the summit of Mount Kenya in East Africa was covered with ice

that descended some 5,000 feet lower than it does to-day. But always the African lowlands would have been warm enough to support life. In New Zealand the glaciers flowed down from the mountains right into the sea. One of the oddest features of New Zealand to-day is the way in which the dense subtropical vegetation grows almost up to the foot of the glaciers on the mountain slopes; and doubtless it did the same in Pleistocene times. In South America there were only local ice sheets.

This is all very well, you will be saying, for animals that happened to live in Africa or New Zealand or South America. But how could those that lived in Europe, for instance, swim across the Mediterranean to Africa? The answer to that question is, first, that many species, as we have said, did not escape at all; and second, that Pleistocene geography was as different from ours as was Pleistocene climate. The birds, of course, could fly over,



Photo by N. Y. Botanical Garden

Not all of the Ice Age was bitterly cold. There were times called "interglacial periods" when the ice withdrew far to the north and plants and animals could thrive in the places it had deserted. The tree of which we have the fossil leaves above, lived in the Pleistocene.

## THE RECORD OF THE ROCKS



Photo by Field Museum

This handsome animal is the Irish elk, one of the animals who survived the bitter Ice Age. He would

still be alive to-day if man had not killed him off sometime in the thirteenth century.

water if they needed to; and it is supposed that they learned at that time the habit of migrating southward every year, a habit which many species keep to this day. As for the mammals, they would not have found the same water barriers as they would find to-day.

### When Europe Was Joined to Africa

For luckily there were still land connections in places where water now flows. Europe was raised higher above the sea than it is now, and the British Isles were united with each other and with the mainland in a great northwestern peninsula. The English Channel and most of the North Sea were then dry land. Europe was joined to Africa in the south by a land bridge between Spain and Morocco, where the Straits of Gibraltar are to-day, and by another land bridge between Italy, Sicily, Malta, and Tunis. The Adriatic and Aegean seas were mostly dry land, and thus the Greek islands were connected with the continent. So it would be much easier for European animals to migrate to warmer countries than it would be now.

Then, too, Asia and North America were joined to each other by a wide land bridge which spread across what is now the Bering Sea. North and South America, which had before been separated by vast seas, were during the Ice Age joined by a wide strip of land now represented only by the narrow Isthmus of Panama. Across the Pacific in Asia, the continent mass also stretched far into what is now the ocean; the Malay Archipelago, Borneo, Java, Sumatra, Celebes, the Philippines, Japan, and Formosa were all parts of the mainland. Yet even with all these land bridges across which to escape, so many of the plants and animals were destroyed that vast areas of the earth's land surface lost the greater part of the life that had existed in them.

### The Last Page in the Record of the Rocks

The changes and migrations naturally meant a great mixture of fossils in the rocks. Thus in the south of France and in England we find the fossil remains both of animals typical of cold countries and of those typical of warm lands—there will be reindeer, musk

## THE RECORD OF THE ROCKS

Millions of years ago the young earth was entirely covered with water. Then, as we believe, dry land was heaved up out of the sea; and instantly little streams and rills fell to work upon it, tearing it down and carrying it grain by grain to the ocean. There it was spread neatly upon the ocean's floor, layer upon layer. Now in that far-off day all the living creatures there were, made their home in the sea. When they died their skeletons sank down and were gradually buried in the sand and mud brought down by the streams. As centuries passed, the sand was turned to stone—which to this day contains those ancient skeletons!

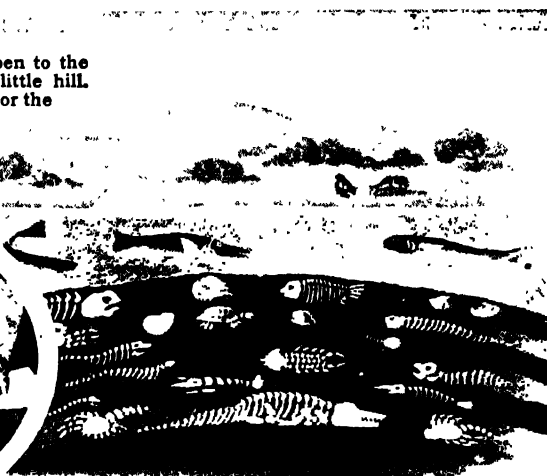
Thousands upon thousands of years have passed, and our little stream, with countless others like it, has nibbled down the hills considerably, as you may see for yourself; and all that sand and gravel has gone to make layers of many different sorts on the sea's floor. Now during all these countless centuries the early simple forms of life have developed into much higher and more varied forms. Animals have now learned how to live on land, and a vegetation which can support them has gradually grown up there. But all these newer forms of life must die, just as the old forms did. And as they die, they will sink down to the bottom of the sea, or their dead bodies will be washed down by the streams and rivers, and slowly they too will be neatly buried in sand that will finally turn to rock.

Our little stream has grown into a river, and it has been so busy during all these millions of years that it has almost carried our hill away—but not far! There the hill is, spread out in layer upon layer of sand and gravel at the bottom of the sea. And in every one of those layers are buried the skeletons of the animals that lived and died as the layer was being deposited. Higher and higher forms of life have appeared upon the earth. We have horses and cows and other mammals. But they too must die and be buried. It is not very different from what would happen if you slowly buried your ashes in sand when they died in your goldfish bowl.

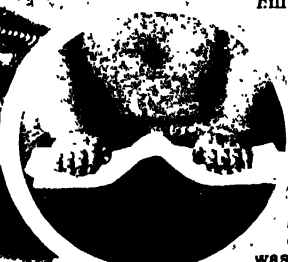
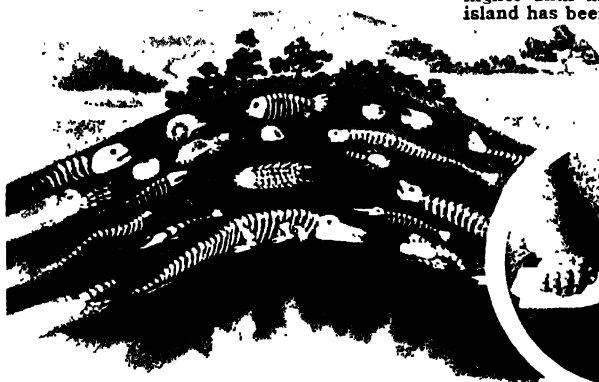


## THE RECORD OF THE ROCKS

And now an interesting thing begins to happen to the layers of rock that were made out of our little hill. The crust of Mother Earth begins to wrinkle, for the good old dame is shrinking and her "skin" has grown too large. And as it wrinkles, parts of it are pushed up and other parts sink down, till it is as uneven as the skin of a baked apple that has been out of the oven an hour. As it happens, the layers of rock that were made from our age-old hill are gradually being forced up into a mound by terrific pressure from either side. The layers are undisturbed, but now they no longer lie flat. You can see what is happening if you will push together the folds of a napkin with your hands, as the girl in the picture is doing.



As the pressure from either side grows greater and greater, the layers of rock are pushed up higher and higher until they finally rise out of the sea. A new island has been born. The wind and rain fall to work upon it and powder the surface of the rock into sand; and birds and waves bring seeds that take root and grow into a rich vegetation. And so that first little hill that was worn away while the world was still young now finds itself dry land again, the home of a forest. But now the rocks that form it are not one solid mass, but lie in many different layers, each one made from a layer of mud or sand or gravel that was laid down in the sea.



Higher and higher our island has been upreared, and now man has appeared upon the earth. He goes busily prying about to see what may be of use to him, and sooner or later discovers all the valuable treasure the coal and metal and building stone—that are buried in the earth. So he sets to work to dig them out. And as he digs he comes upon those ancient skeletons—"fossils," we call them. Before long he learns how to read the record of the rocks, which tells us the long story of life upon the earth. And today, by judging the age of a rock, a modern scientist can even tell us in what age the buried creature lived.



## THE RECORD OF THE ROCKS

TABLE ILLUSTRATING WHEN THE VARIOUS FORMS OF LIFE ARE FIRST FOUND IN THE RECORD OF THE ROCKS		PROTOPHYTA & PROTOZOA SIMPLEST ONE-CELLED FORMS OF LIFE	SPONGES	CORALS	STARFISHES	SEA URCHINS	CRINOIDS (SEA LILLIES)	WORMS	TRILOBITES	XIPHOSURA (KING CRAB)	PHYLOPODA & OSTRACODA (SMALL CRUSTACEA)	BRACHIOPODA LAMP SHELLS	MOLLUSCA	INSECTS	FISHES	AMPHIBIA	REPTILES	BIRDS	MAMMALS	MAN
ERA	PERIOD																			
CENOZOIC OR NEW LIFE	QUATERNARY	RECENT																		
		PLEISTOCENE																		
		PLIOCENE																		
		MIOCENE																		
	TERTIARY	OLIGOCENE																		
		EOCENE																		
MESOZOIC OR SECONDARY		CRETACEOUS																		
		JURASSIC																		
		TRIASSIC																		
PALEOZOIC OR ANCIENT LIFE		PERMIAN																		
		CARBONIFEROUS																		
		DEVONIAN																		
		SILURIAN																		
		ORDOVICIAN																		
		CAMBRIAN																		
PROTEROZOIC OR EARLIER LIFE	ALGONKIAN																			
ARCHEOZOIC OR DAWN OF LIFE	ARCHEAN																			

The table given above will tell you when the various forms of life put in an appearance in the history of the earth. At the left the various geologic eras and periods are given. The heavy black lines running crosswise of the page might be taken to represent the layers of rock laid down during each period. The earliest age is at the bottom, the latest is at the top. Along the top of the chart are listed the various forms of life that have appeared in the earth's history. The

earliest and simplest forms are at the left, the latest and highest are at the right. The fine black lines running up and down on the chart show the length of time the race whose name is printed above them endured. The lower end of these lines shows when the race first appears in the rock record; the upper end shows whether it disappeared. For instance, the trilobites, whose name appears midway in the list, appeared in the Cambrian and disappeared after a time.

ox, hairy mammoth, woolly rhinoceros, lemming, wolf, cave bear, lion, leopard, hippopotamus, deer, and antelope, all mixed up together.

All through that Age of Ice man too was battling the elements and struggling ever upward in mentality. We find traces of him in the interglacial epochs in Europe and the Mediterranean region. Then at last, perhaps 30,000 years ago, the Pleistocene period came to a close, as the ice retreated, apparently for the last time, to the polar regions. Now begins the Recent period, in which we are living to-day. And that period is above all the Age of Man.

We have told the story of the earliest beginnings of man, so far as we know them,

elsewhere in these books. It is the latest chapter in the history of the upward climb of life. But it is told in fragments of tools and bits of art more often than in such bits of bone and impressions in the rocks as we have called fossils. So we close the Book of the Rocks here—a second or two ago by the earth's long calendar, and some tens of thousands of years ago by ours. What a pageant of wonder and mystery we have seen as we turned the leaves of that great book!

The most inspiring thing to remember is that, far as life has come on its journey, it is still traveling. These pages of the book are only the *latest*, not the last. The future chapters of the mighty story are for us to write as we will.



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# **The ANIMAL KINGDOM**

## **(Zoology)**

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### **Reading Unit**

#### **No. 1**

## **HOW WE CLASSIFY THE ANIMALS**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

### ***Interesting Facts Explained***

The two divisions into which all creatures are divided, 3-68  
The class to which we belong, 3-68  
Which is the largest land animal—  
which is the smallest? 3-70

What kind of creatures belong to the second division? 3-69  
How a woodman can tell where to look for the forest folk, 3-70

### ***Things to Think About***

Are animals really "dumb"?  
Where do the Amphibians live?  
How do our four-footed kinsfolk resemble us?

How the weaker animals escape from their enemies.  
How we can learn the ways of the animals.

### ***Picture Hunt***

Which animals are man's closest friends? 3-66-67  
To which classes do the animals on page 3-68 belong?  
Why do the queer creatures on page 3-69 belong to the lower

division?  
Why does the crab wear a coat of armor? 3-69  
What does the coral look like? 3-69

### ***Related Material***

How does a fish breathe? 3-196  
How do birds travel? 4-3  
What birds have forgotten how to

fly? 4-232-39  
What mammals live in the water? 4-327-35

### ***Leisure-time Activities***

Make a chart of all the animals you can think of belonging in the

five classes of the Vertebrates.

### ***Summary Statement***

All of earth's creatures are classified in two divisions. In the first division are the vertebrates, or creatures with a backbone and a skull; here are mammals, birds, reptiles, amphibians, and fish. In

the second division are the invertebrates, or animals with neither backbone nor skull; here are worms, insects, jellyfish, sponges, coral, etc.

## HOW WE CLASSIFY THE ANIMALS



Photo by Kuchgits

This famous painting by Sir Edwin Henry Landseer is called "Saved," but no title is needed to explain that the panting hero who holds the little girl upon his forepaws has just saved her from drowning. Of

all the animals which have become man's servants or his playfellows, the dog is man's closest friend, for he is affectionate, intelligent, and often more trustworthy than man himself!

## HOW WE CLASSIFY *the* ANIMALS

### *And Why We Put the Mammals, with Man in the Lead, at the Top of All of Them*

**T**HERE is an old fairy tale about a boy who by some magic means was able to hear and understand all that the beasts on his father's farm and the wild animals of the countryside said to one another. He could interpret the sleepy murmur of the cows as they lay chewing their cud in the meadow, could understand the grunts and grumbles of the pigs in the sty, could listen to the words of wisdom falling from the staid old cart horse, and the friendly gossip of the little gray rabbits as they chatted together in their doorways in the cool of the evening.

How delightful it would be if we too possessed a fairy charm like that! What surprising things we might hear, what wonderful things we might learn, if we could travel round the world listening to all the wild creatures we met as they went about their busi-

ness—playing, hunting, courting, working, training their children, and doing the hundred and one things that go to make up the everyday life of our four-footed friends and foes.

Of course animals do not have such complicated languages as human folk, and they do not hold such lengthy conversations and arguments as we do; but nearly all animals have some way of communicating with their fellows and of expressing their feelings by sounds as well as in other ways. So it is not really quite correct to speak of them as "dumb" animals. Dumb, indeed! Surely no one who has heard a lion roar, a monkey chatter, or a mouse squeak ought to call the creatures "dumb"—unless he merely means that they do not learn to talk a language such as he can use.

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## HOW WE CLASSIFY THE ANIMALS

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The horse is another of man's faithful friends. Many an Arab's life has depended upon the swiftness of his

steed, and many a traveler, lost in the depth of the forest, has been led to safety by his horse.

Animals, as we well know, bark, grunt, bellow, whine, squeal, bleat, or purr, expressing pleasure, rage, pain, fear, or affection, each one in its own particular way. Even without a magic charm we can generally tell by the kind of noise an animal makes, whether it is pleased or hurt or angry; and even when we can understand no more than this from their remarks, we may have other ways of learning something of the lives and customs of the interesting four-footed folk of the animal world.

### The Wonder World beyond Our Cities

It is good for us sometimes to remember that we are not the only important beings living on God's good earth. Beyond the boundaries of our great towns and cities lies another and more wondrous world. In place of hard pavements and crowded buildings are green hills and vales, rolling plains, deep, quiet forests, shady woods, broad rivers, and

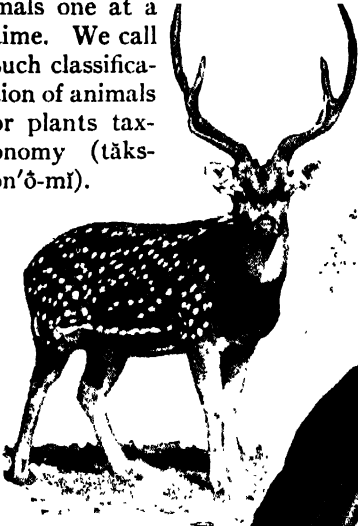
trickling rills. Instead of the roar of traffic and machinery, there is the sound of murmuring streams, the song of birds, the soft rustle of leaves, and the mysterious little noiseless noises telling of hidden life and movement on every side.

Here is Nature's realm. And here Nature's children, the beasts, the birds, and the numberless lowly creatures that swell the population of the animal world, live and work and fight and play just as Nature intended them to do.

The amazing numbers of different living creatures seem absolutely bewildering when at first we consider them. But just as a great army is split up into divisions, battalions, regiments, and companies, so the almost overwhelming hosts of the animal world are marshaled in regular groups and arranged in classes, orders, tribes, and families. Every animal has his own proper place; so we can study the different groups of ani-

## HOW WE CLASSIFY THE ANIMALS

mals one at a time. We call such classification of animals or plants taxonomy (tăks-ŏn'ŏ-mĭ).

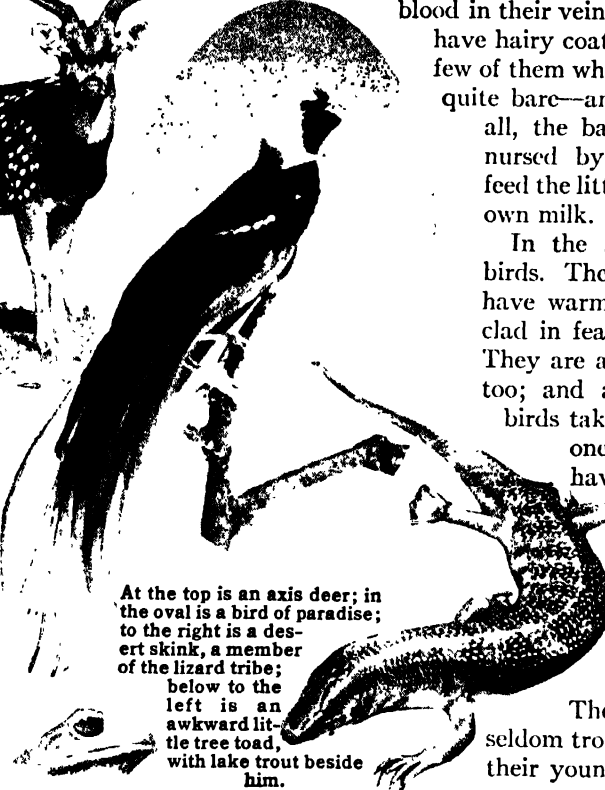


All these creatures of the animal world are classed in one great division. They are called the vertebrates, for they all have a jointed backbone and usually a skull, although some are furry and walk on four legs, some have feathers and fly, and some creep around on their slimy skins or make the water flash with their shining scales.

Photos by N. Yi  
Zoological  
Society



At the top is an axis deer; in the oval is a bird of paradise; to the right is a desert skink, a member of the lizard tribe; below to the left is an awkward little tree toad, with lake trout beside him.



In the first class of the first division are placed the mammals, the most important and intelligent of living creatures, with man himself standing right at the top of the class.

These superior animals have warm red blood in their veins, they breathe air and have hairy coats—though there are a few of them whose skins are almost or quite bare—and most important of all, the babies in this class are nursed by their mothers, who feed the little creatures with their own milk.

In the second class are the birds. They, too, breathe air and have warm blood, but they are clad in feathers instead of hair. They are all hatched from eggs, too; and although the mother birds take care of their young ones and feed them, they have no milk to give them, as all the mammals have.

In the third class come the reptiles—cold-blooded, creeping creatures covered with scales.

They lay eggs but they seldom trouble themselves about their young ones, who are quite

All earth's creatures are separated into two divisions, an upper and a lower one. In the first division are grouped together all the higher animals—called vertebrates (vŭr'tĕ-brăt). These possess a backbone made up of movable joints, and usually have a skull.

The second division contains the lower animals—called invertebrates (ĭn-vŭr'tĕ-brăt)—which have no backbone or bony skull.

able to look after themselves as soon as they are hatched.

In the fourth class we have the amphibians (ăm-fĭb'ĭ-ăn)—the frogs, toads, and newts—which pass the first part of their lives as tadpoles, living and breathing in the water like the fishes, and the rest of their days as air-breathing animals on the land.

In the fifth and last class are the fishes—

## HOW WE CLASSIFY THE ANIMALS



Photos by Cornelia Clarke, N. Y. Zoological Society, and A. S. Peck, American Museum of Natural History

These queer creatures belong in the lower division of the animal kingdom, for none of them have backbones. At A is a little sea sponge, which is often taken from his watery home, dried, and returned to the water again—in your bathtub! The coral at B looks somewhat like a rock and, indeed, great masses of corals often make up many feet of ancient limestone. The little beetle at C has millions of relatives in every part

of the world. At D are some of the billions of sea animals which you couldn't possibly see without a microscope. The crab at E wears a coat of armor which takes the place of a backbone to hold his soft parts in place. At F is a member of the spider tribe. At G is a king crab half concealed by some sea anemones who have decided to roost upon his back. And at H is our familiar friend, the oyster.

the lowest and least intelligent of the backboned animals. They are cold-blooded, breathe with gills, and as a rule are clothed with scales.

In the second division of the animal kingdom—made up of animals that have neither backbone nor skull—are a multitude of creatures such as worms, insects, spiders, crabs and lobsters, shellfish, jellyfish, sponges, corals, and numberless lowly forms of life

too small for our eyes to see without a microscope, the lowest of all looking like mere specks of living jelly—though even these are very complex creatures.

The animal world is indeed a world of infinite marvel, filled with an astonishing collection of living creatures highly various in form, in size, in habit, and in intelligence. There is so much to learn about all these creatures, so much to interest us in every

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## HOW WE CLASSIFY THE ANIMALS

single class, that we can never possibly know it all. But it is the highest class, the class of mammals, that attracts us most—partly because we belong to it ourselves.

In our four-footed kinsfolk, so like us in some ways and so unlike us in others, we cannot help being interested. They have the same senses that we have—sight and hearing, taste and touch and smell—though in the senses of touch and smell they beat us every time. They feel pleasure, anger, pain, and fear just as we do, though they have not learned, so well as we have, to control these feelings. They have brains, too, as we have; and although they act by instinct rather than by reason, many of them are wonderfully clever and intelligent.

### From Shrew Mouse to Whale

There are altogether nearly three thousand different kinds of mammals distributed all over the globe. Nimble monkeys, ponderous elephants, flying bats, prickly porcupines, fierce lions, tigers, bears, and wolves, and jumping kangaroos all belong to this highest class of animals; together with many odd creatures that one would hardly take to be warm-blooded mammals, such as the great whales, which have two flat flippers instead of four legs, and spend all their days in the sea. The largest of all land animals is the big African elephant, which may be over eleven feet high at the shoulder; and the smallest is the pigmy shrewmouse, which is only about two inches long from the tip of its pointed nose to the tip of its tiny tail!

In all parts of the world—in hot tropical countries, in cool temperate lands, in icy northern regions—wherever there is any kind of vegetation to support life and even in desolate places where hardly a green blade grows, some of the warm-blooded, four-footed folk are sure to be found. They may make their lairs in the grass or tangled scrub; they may live in caves and holes, or may burrow underneath the ground. They all have their likes and dislikes. They choose the kind of home that suits them best, and they are all marvelously fitted for their own particular way of life.

Savage hunting beasts have strong teeth

and sharp claws for capturing their prey. Weaker, hunted animals are swift or cunning in their ways of escaping the hunters. Some are protected by armored suits or prickly coats. Others have a disagreeable odor which drives their enemies away in disgust, while many wild creatures are dressed to match their natural surroundings so cunningly that they often elude the sharpest eyes.

With so many four-footed folk in the world, it may seem strange that we see so few of them, even in the wildest places, where we might expect to find them most easily.

That is because the wild folk are very shy. They seldom show themselves boldly when strangers are about. Many of them, too, turn night into day, and do not come out to feed and play until we are going to bed.

Yet if we know how to look for them we may see signs of our four-footed friends and foes all around in their own territory. A woodman will tell us, from the footprints on the ground, where a herd of deer has passed or in which direction Bre'r Fox went hunting last night. The marks on a tree trunk will show him where a bear has paused to sharpen its claws; and a fresh heap of earth among the roots of an old tree will betray the spot where a woodchuck has been digging its underground home.

### How to Learn the Ways of Animals

There is nothing more exciting than to follow the trail of some wild animal that we have not seen before, to see what we can find out about it.

But we need to be as silent as the little creatures themselves if we are going to watch them at their housekeeping arrangements. And we need to have quick wits, a sharp eye, and a kind of sixth sense that will tell us under just what pile of stones a chipmunk is likely to have set up his establishment, or in just what hollow tree a raccoon is probably sleeping. And most of all we must have the instinct of the scientist, which makes us feel it a greater triumph to have watched one of the beautiful things in its home than to have brought down a dozen of them with a shotgun or rifle.

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# ***The STORY of LIFE in the SEA***

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## **Reading Unit No. 1**

### **DOWN WHERE THE MERMAIDS LIVE**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

What we can find on the bottom of the sea, 3-73-74  
How the sea got its salt, 3-74-76  
How new rock layers are being made to-day, 3-76-77

The work done by the microscopic Foraminifera, 3-77-79  
The cause of strange lights in the waves, 3-80

#### ***Things to Think About***

How much of the earth is covered by water?  
How is the supply of salt in the ocean increased daily?  
What happens to sand that is carried down from the mountains?

What part do the shells of the Forams play in making new land?  
What is the meaning of "radiolarian ooze"?  
What do we mean by "light without heat"?

#### ***Picture Hunt***

How is it that the seashore can be both a playground and a zoology book? 3-72, 75  
Why do we call certain tiny animals "Radiolaria"? 3-76-78, 79-80

How are some of our buildings indebted to the microscopic Globigerina? 3-77  
Can you tell why so many people speak of the sea floor as a garden? Color plate 3-70

#### ***Related Material***

How do volcanoes build up land? 1-76

How does the sea force land to return to the sea? 1-69-70

#### ***Leisure-time Activities***

PROJECT NO. 1: To study the microscopic life of the sea, examine a few drops of ocean water

under a microscope. Can you find any Forams? 3-77-80

#### ***Summary Statement***

The ocean floor has a scenery all its own, with fish and other sea life of all shapes, sizes, colors, and interesting habits. The ocean water is salty because each stream or river carries sand and dissolved salts from the hills and mountains down to the sea. The

sand settles to make sedimentary rock, and the salt is added to the already plentiful supply in the sea. Microscopic Forams, Radiolaria, and other animals build shells which later sink to the ocean floor and build new land.

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## THE STORY OF THE SEA

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Photo by Florida East Coast Ry.

The biggest playground in the world! Twice a day, when the tide goes out, it leaves a clean slate to write on, tons of fresh sand to build with, and a brand-new

set of trinkets of all kinds--seaweed and bright shells and creatures of amazing strangeness. Their variety seems endless, and their way of life most interesting.

### DOWN WHERE *the* MERMAIDS LIVE

*Far Down in the Ocean's Depths and All along the Shore Live  
Creatures as Strange as Any of Those in Fairy Land and  
as Beautiful as the Loveliest Flowers*

**F**AR out in the sea the water is as blue as the petals of the most beautiful cornflower, and as clear as the purest glass. But it is very deep, deeper than any cable can sound; many steeples would have to be placed one above the other to reach from the bottom to the surface of the water. And down below live the "sea people."

The sea people in Hans Andersen's delightful tale, "The Little Sea-Maid," were mermaids and mermen, sea kings and sea queens, who lived in castles of rosy coral and pale golden amber, played on golden sands, and floated hand in hand through

groves of tall sea plants, where rainbow-clad fishes glided through the waving branches, just as birds flit about among the trees in our own everyday world.

There were fascinating caves and grottoes in which the little mer-children played hide-and-seek; and the sea floor blossomed with wonderful gardens of sea flowers for them to tend. But there were fearful forests of dark, writhing polyps—"half animals, half plants"—that clutched at them with long, snaky arms if they were bold enough to venture near; and there were terrible sea witches, hundreds of years old, ugly enough to make one shudder.



## THE STORY OF THE SEA

Now if we could plunge down, down to the bottom of the sea and wander as we pleased under the blue water, I am afraid we might look in vain to-day for the curious sea people of the old fairy tales. It is hardly likely that we should disturb a mermaid combing her hair in a coral grotto, or be startled by an old sea witch peering out at us from a gloomy cavern. But we should have no time to feel disappointed at this, for we should find ourselves surrounded by so many strange and bewildering sights that we might well imagine we had somehow strayed into an enchanted kingdom.

Here in a dim, blue, mysterious light, a magic city of coral castles and fairy palaces rises from a floor of finest silver sand and rainbow-tinted shells. Domes and spires, towers and pagodas, that might have come straight out of the "Arabian Nights," surround us

sponges and sea anemones of every hue, where dainty jeweled fishes, gay as humming birds, dart here and there, light as air bubbles, or poise motionless in the water, gently waving their little fins. Shoals of mild-eyed fishes, forever nibbling and nibbling, like a flock of grazing sheep, move slowly together over wide-stretching meadows—blue, green, red, and brown.

Others chase each other in and out of the rocks in a never ending game of follow-the-leader.

Queer little fishes, for all the world like gnomes and hobgoblins, peer from holes and sheltered nooks. Numbers of small, oddly shaped creatures creep and glide about the rocks and slip hastily away out of sight when the shadow of some big fish passing overhead causes a sudden panic among the more timid sea folk. In the deeper, darker waters

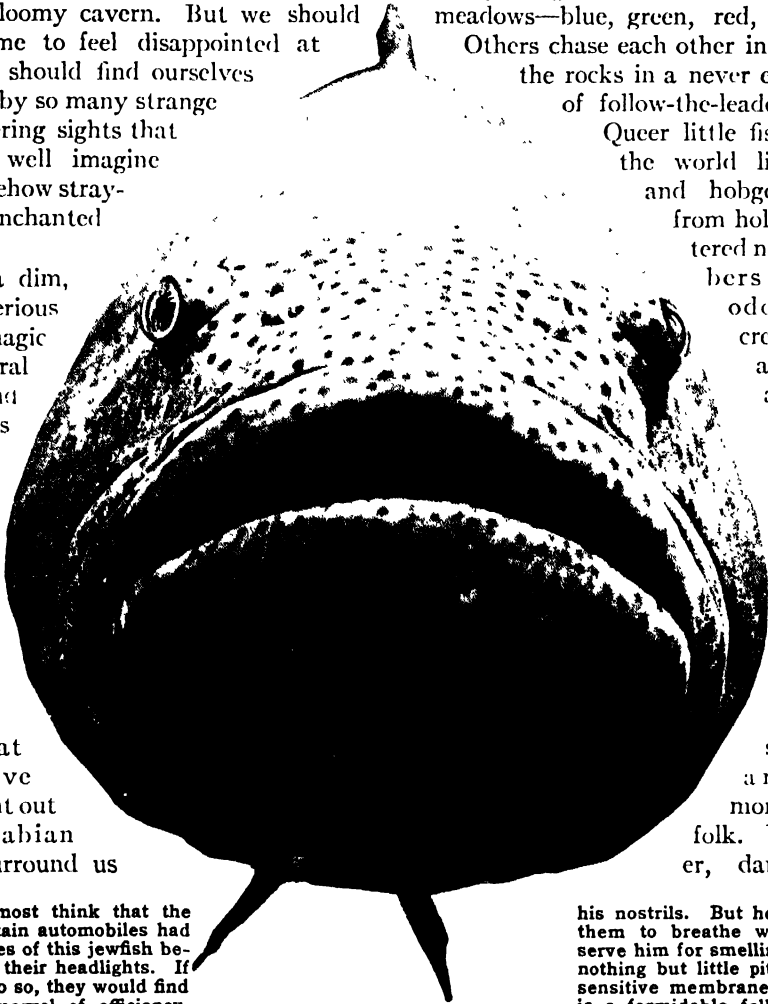


Photo by N.Y. Zoological Society

One could almost think that the makers of certain automobiles had studied the eyes of this Jewfish before designing their headlights. If they were to do so, they would find him quite a marvel of efficiency. Like all other fish, the Jewfish has eyes with lenses almost as round as a marble, for that helps him to see under water. But what a strange-looking place the world must be to him! The two little holes not far from either eye are

his nostrils. But he does not use them to breathe with—they only serve him for smelling, for they are nothing but little pits lined with a sensitive membrane. The Jewfish is a formidable fellow. He lives along the coast of California, where he gets to be seven feet long and weighs at least five hundred pounds. And yet this mighty creature is a perch!—and no more strange to look at than countless other beings that share his watery home.

on every side. We may discover a real Aladdin's Cave stocked with treasures of precious coral, glistening mother-of-pearl, and sparkling crystals; or wander into a wondrous rock garden, gorgeous with colored

mysterious lights shine out here and there from the rocks on the sea floor or pass swiftly overhead leaving gleaming trails behind them.

All sorts of thrilling adventures, too, may

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## THE STORY OF THE SEA

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befall us in this wonderful kingdom of the sea. We may meet alarming-looking creatures, clad like knights of old in complete suits of armor and carrying weapons of fearsome spines and spikes. Or we may encounter a terrifying sea monster with gaping jaws that will make us wish ourselves safely on dry land again.

Then there are those bewildering sea people who have a startling habit of altering in shape and turning themselves into something else as you look at them. A weed-covered stone at your feet—or what looks like one—will suddenly come to life and calmly walk away; a lovely, flowerlike thing will shrink up and transform itself into a dull-looking lump of jelly if you touch it; a slight hump in the sand will suddenly heave itself up and swim away as a large, flat fish with head and tail and fins complete. There are indeed so many astonishing creatures living under the salt sea waves and their ways and manners are so extraordinary that the story of the real sea people is as thrilling as any fairy tale that ever was told.

Now before we make the acquaintance of the interesting inhabitants of old Father Neptune's kingdom, it is just as well to know something of this wonderful water world of theirs. There are vast multitudes of creatures living in the sea—many, many more than there are land creatures living on firm dry ground. For the waters of the earth take up more than twice as much space on the surface of the globe as the land does. To be exact, if the earth's surface were divided into seven equal parts the sea would cover five of them. In some parts of the ocean the water is several miles deep, much too deep for any diver to go down to explore

the sea bottom. Yet we know that in these dark depths countless delicate sea people live out their strange lives, moving about under an enormous weight of water that would crush you or me as flat as a steam roller would. But these dainty creatures live here as comfortably as their relatives who make their homes in the shallow sunlit pools of the seashore. No matter whether the water

be deep or shallow, warm or cold, clear or muddy, it is sure to be inhabited by a vast population of strange and interesting animals of all sorts and conditions. Some live in the surface waters, some swim about at different depths, and others pass the whole of their lives deep down at the bottom of the sea.

There are hills and valleys under the sea just as there are on dry land. There are vast plains and gentle slopes covered with sands and gravels of different colors. Here and there are raised terraces and steep cliffs, and far out in mid-ocean are deep,

dark abysses where the sun's rays can never penetrate.

The surface of the sea, as we well know, is often lashed to frenzy by fierce gales. The angry waters swirl and gather into mountainous waves strong enough to batter and sometimes even to sink the biggest ocean liner. Yet only a short distance below the wild tumult, the water is hardly agitated. The lower you go the calmer it grows; and the sea folk living at or near the bottom of the sea are not at all disturbed by the storms raging over their heads.

### How the Sea Got Its Salt

Of course everyone knows that the sea is salt, but not everyone, perhaps, could tell us why this is so. In olden days, before



Photo by American Museum of Natural History

The scenery of the under-water world is often as strange and picturesque as the little creatures that dart about in it so rapidly.

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## THE STORY OF THE SEA

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One after another in steady procession the great waves come thundering in. And as we watch them break and

foam we never remember that in their arms are countless forms of life that are beautiful and strange.

people had learned very much about this wonderful world of ours, many quaint tales were invented to account for the strange saltiness of the "briny ocean." Here is one of the best, I think.

### The Magic Mill

A certain miller possessed a couple of millstones which had the delightful power of grinding out of nothing at all whatever their owner desired. Did he wish for gold, food, clothing, or any pleasure or luxury? He had only to say,

"Mill, mill, grind away;  
Grind me silver and gold, I pray—"

or anything else he needed at the moment. So the lucky miller lived in great contentment, doing no work, yet having everything he wanted without the slightest trouble. But his neighbors grew envious and were always trying to find out the secret of his wealth. This he prudently kept to himself and would not tell anyone.

At last one day a seafaring man hid behind the millhouse door and overheard the miller repeat the magic rhyme. Then, fearing he might be discovered, he ran off as fast as he could. In the dead of night, he came back with some companions, and together they stole the millstones and carried them away to their ship.

When they were far out to sea the men began to prepare a meal; but they found they had no salt on the ship. Thereupon, the thief who had learned the magic rhyme ordered the stones to grind salt for him. Immediately the stones began to grind, and a stream of salt poured forth upon the deck. "That's enough," cried the man. But the stones paid no attention to him. Too late he realized that, although he knew how to start the stones grinding, he did not know how to stop them. He tried everything he could think of, crying "stop," "cease grinding," "we don't need any more salt." But it was no use; the millstones went on grinding until the ship sank beneath the weight of the salt and went down, down to the bottom of the sea. The men, of course, were drowned; but the stones went on grinding. As no one knows where they are, or how to stop them if they could be found, they go on steadily grinding out salt until this day.

### The Rivers Are the Salt Cellars

The idea of the old millstones grinding away for ever and ever at the bottom of the sea is very fascinating, but the real, sober truth is that the salt is carried down to the sea by all the rivers of the world that flow into it. That fresh water should make sea water salty seems at first a topsy-turvy kind

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## THE STORY OF THE SEA

of notion. But so it is. All rivers really contain salt, though in such small quantities that if we taste the water we do not notice it. The average amount of salt in river water is only about twelve grains to the gallon—sometimes more, sometimes less.

The salt in the river comes in the first place from the earth's surface. The rain descends upon all the continents and islands of the world and dissolves small quantities of mineral salts out of the rocks upon which

into the sea, while the waves are forever pounding upon the rocks near the shore and breaking off fragments, which are ground into powder and washed away by the tides.

### Tireless Mother Nature

Dame Nature is always at work, hewing and carrying and altering the face of the earth. Her tools are the wind and the frost and the rain, the little springs and the waves, and her grindstone is the seashore, where

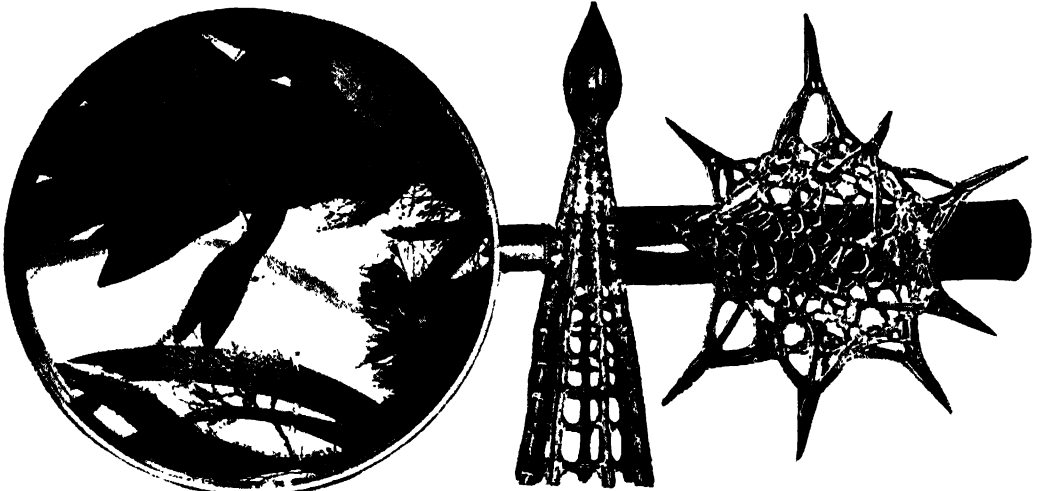


Photo by American Museum of Natural History

If your eyes could magnify things fifty thousand times, two inches of sea bottom would look like the picture on the left. The skyscraper tower in the center and the bit of lace to the right are really the limy skeletons

of tiny creatures too small to be seen with the naked eye, but with a name that makes up in length for the owners' small size. They are called Radiolaria, which comes from the Latin for "little rays."

it falls. The dissolved salts are washed away by the streams and rivers as they wander through the land on their way to the sea.

For millions of years the rivers, like the magic millstones, have been pouring salt into the sea—and leaving it there. So the sea grows ever saltier and saltier. Fortunately, however, the change is taking place so slowly that I do not suppose anyone will notice it for another million years or so. We need not worry ourselves about that.

### Where the Mighty Rocks Are Made

For untold ages the rivers, the winds, and masses of floating ice have been carrying all sorts of materials to the sea to help form a carpet for the great rocky floor of the ocean. Particles of earth, dust from the deserts and volcanoes, are always being washed or blown

the pieces of rock that are split from the cliffs by her chisels and hammers are beaten and pounded into pebbles and finally ground into sand.

But it is not only from rocks ground up by the waves, dust blown by the winds, and earth carried by the rivers, that the thick carpet of sand and mud and ooze covering the floor of the oceans has been formed. Sea creatures themselves have played an important part in its manufacture. Deep layers of crushed and broken shells, mixed with the brittle skeletons of numberless sea folk that have lived and died in the sea, extend for miles at the bottom of the Atlantic, Pacific, and Indian oceans. It is not so much the monsters of the deep, the whales and giant fishes, that have contributed chiefly to the making of these layers—though

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## THE STORY OF THE SEA

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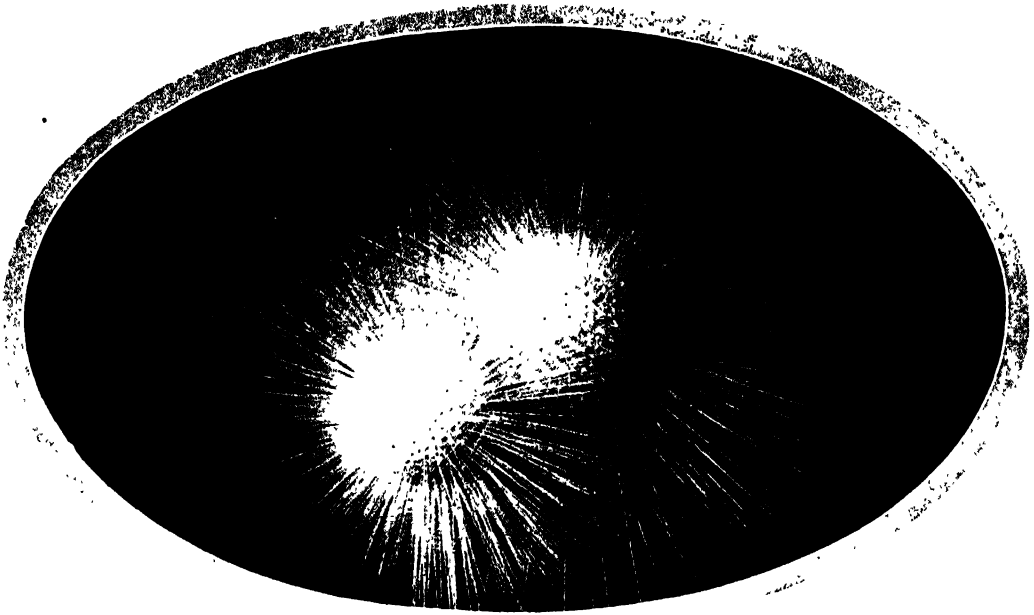


Photo by American Museum of Natural History

You can imagine how fine the threads are on these little *Globigerina* when you know that in real life the whole animal is the merest speck. Yet it was billions

of these tiny creatures that ages ago gave their skeletons to help make some of our limestone. See the tiny holes through which the long "feelers" are sent out.

their bones are of course being constantly added to the piles accumulating below. It is formed from the little sea creatures, the million upon million of tiny living things, many no bigger than specks of fine sand or dust, that swarm in the ocean from China to Peru.

### Little Beasts with Big Names

Little things nearly always seem to have long names. That, I suppose, is why some of these living atoms of the seas are called Foraminifera (fô-răm'î-nîf'êr-à). But as that is really much too long a name for everyday use, we will call them "Forams" for short. These Forams belong to the simplest forms of animal life. They are, in fact, nothing more than specks of living jelly. You would hardly think that such tiny things as these could be either interesting or beautiful, but indeed they are; if you once saw some of them under the magic eye of the microscope, you would quickly change your opinion. They really are the most lovely little things, for their shapeless, jellylike bodies are inclosed in the dainty shells, which make the

most charming little dwelling houses imaginable. Some are like crystal globes pierced all over with hundreds of tiny holes, through which a network of fine, glistening threads streams out, surrounding the ball with a cobwebby, rainbow cloud as it whirls and twirls in the water. Some are pearly, fluted shells, with cloudy streamers issuing from a single opening to guide the tiny craft on their way. Others are shaped like vases, goblets, bottles, or spiral shells; but as there are some two thousand different kinds of Forams it would be hopeless to attempt to describe them all.

### Father Neptune's Sand Masons

The sea, the Atlantic Ocean especially, is so stocked with these tiny shell-like things that it is no use even trying to calculate how many there may be living there at the present moment—you might just as well try to count the grains of sand on the seashore. They swarm at every depth of the ocean, from the very surface to the floor of the sea. We do not notice them, for they are much too minute for our eyes to see.

## THE STORY OF THE SEA

The Forams start life as mere blobs of jelly with nothing at all to protect their little bodies. Each one has to build its tiny house—or “test,” as it is called—for itself. They have their own ideas on the subject and each little Foram constructs its home according to the plan approved and always

strange little animal. Some use both fine and coarse grains of sand in their building operations; others mix the tips of sponge needles with the sand; and still other houses are decorated with chips of colored quartz, red and green, orange and amber, which flash like jewels.

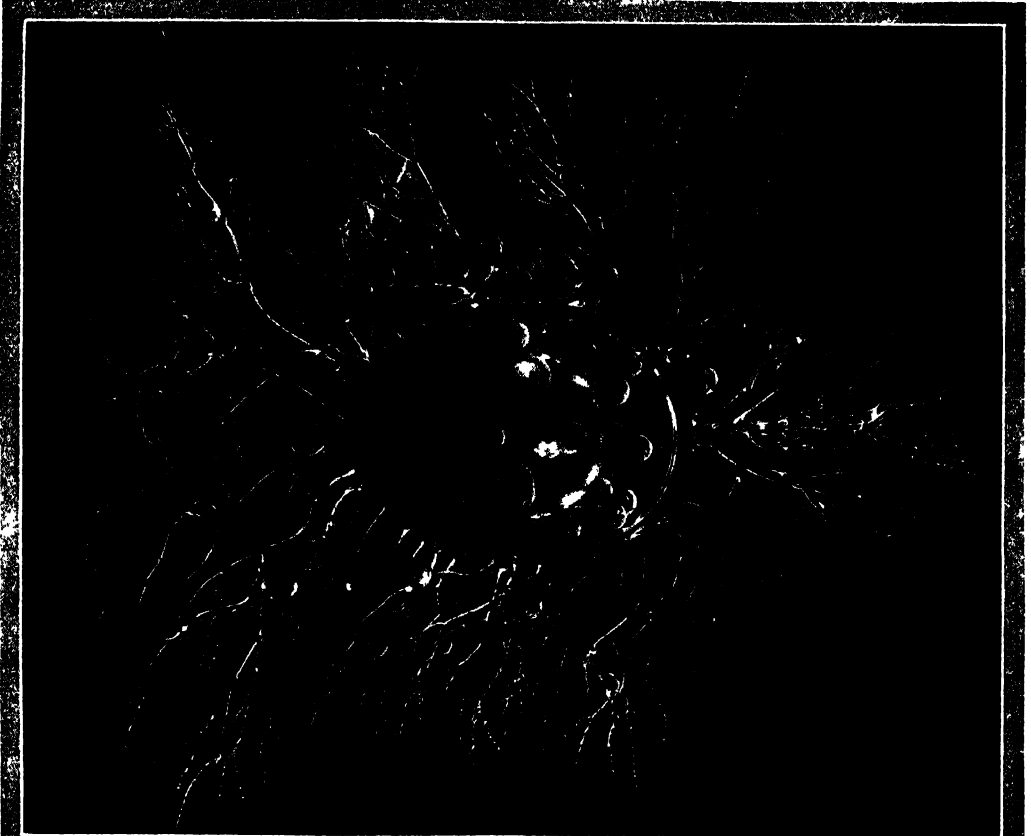


Photo by American Museum of Natural History

This too is a radiolarian. It is one of the great tribe of the Foraminifera. It would be hard to arrange a

more beautiful basket of flowers than you have when you look at it with the left-hand side at the bottom.

followed by its own particular family, or species (spē'shēz), with never a tool to work with and nothing in the shape of a hand, a claw, or a mouth to aid it. One little creature will pick up the finest grains of sand and fashion a flask-shaped residence with a short neck and a single door, or opening. Another will take the coarser quartz grains from the same patch of sand and build them up in the shape of a spiral shell, fixing each grain in position with a kind of natural cement that comes from the body of the

These little “sand masons,” of course, live at the bottom of the sea. Those that spend their days floating about in the water must needs choose some other material with which to form their tiny dwellings. So, instead of sand, the floating Forams use carbonate (kär'bōn-āt) of lime, which they extract from the sea itself. For sea water contains several kinds of salts in solution; and these microscopic, headless, brainless, limbless creatures are able in a wonderful way to select from it exactly the right materials for their work.

## THE STORY OF THE SEA

The tests of floating Forams are of two kinds. Some are smooth and white and look as if they were made of the finest porcelain; others are clear as glass and often covered with long, delicate, tapering spines.

The porcelain shells have only one opening, but most of the glassy ones are covered with minute holes, or pores. Through these pores, or through the single opening, as the case may be, the little inmate pushes forth long, slender threads of jelly which stream out all round it as it moves through the water. These streamers are called "false feet," for by shooting them out on one side and drawing them in on the other the strange little animal can journey in any direction it pleases. But they have another and even more important mission in life, for the Forams use these waving threads as fishing tackle where-with to fish for their dinner. When a microscopic speck of anything eatable floats within reach of these streaming threads, it is surrounded and entangled in a living net. The threads then fuse together, enveloping the tempting morsel in

a blob of jelly; and then and there all the goodness is sucked out of it. Having finished its meal the Foram allows the indigestible portions of the food to float away and draws its streamers inside its shell, in order that the nourishment may be distributed all through its body.

A strange way indeed to eat one's dinner! But then, these peculiar little animals have neither head, mouth, nor stomach! They simply take in food and digest it at any part of their elastic bodies that comes in contact with it!

Now year in and year out unthinkable numbers of these wonderful little sea dwellers

are starting life as invisible atoms in the deep blue sea. They build their tiny houses, live their little day; then, dying, their frail bodies are dissolved away by the salt water. But their indestructible shells sink lightly, gently, down to the bottom of the ocean and are added to the ever increasing pile below. A constant rain of these wee shells is forever falling, falling through the deep waters to the dark depths at the bottom of the Atlantic, especially the shells of one little Foram with the imposing name of "Globigerina"

(glō-bij'ēr-ī'nā).

This species is so abundant that great beds of "Globigerina ooze" extending for thousands of miles under the sea are composed almost entirely of these beautiful, glassy tests.

This rain of microscopic shells has been going on for ages and ages. For the Foraminifera are a very, very old race of tiny beings. Their family history goes right back to the earliest ages, and their ancestors were bobbing about in the ocean long before any of the upstart fishes—who act as if the sea belonged to them—were even thought of.

The story of these little creatures is written for all to read in the records of the rocks, the cliffs, and the hills. Their shells, called fossils (fōs'ıl), are found in some of the oldest rocks of Canada, while the white chalk cliffs and downs of England and the masses of limestone rock in many of the mountain ranges of Southern Europe are largely composed of the crushed shells of these astonishing little animals.

### Where the Hills Came From

But the cliffs and the hills and the downs, you say, are not at the bottom of the sea; so how can they have been built up by the

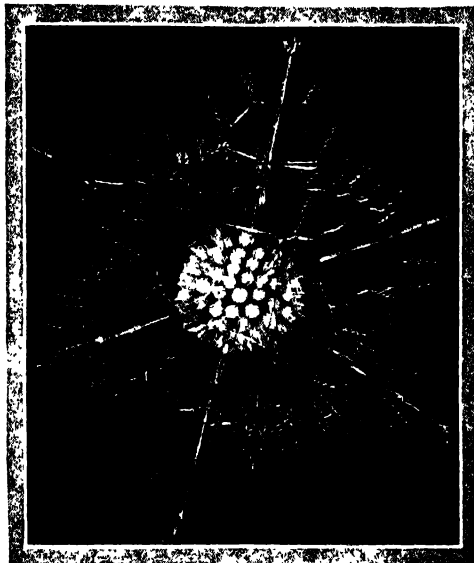


Photo by American Museum of Natural History

This little radiolarian seems to be imitating a snowflake—a thing that is just as exquisite in its own way. But when you remember that you must have a microscope to see this beautiful lace, it makes a snowflake seem coarse beside the tiny animal.

## THE STORY OF THE SEA

little Foraminifera? No, the cliffs and hills and green, grassy downs are not under the sea now, but once they were. In the long, long ages that have passed away, great changes have taken place in this old world of ours. Much of the earth's surface that today is high and dry was at one time, ever so long ago, completely covered by the deep, rolling waters.

"There rolls the deep where grew the tree.  
O earth, what changes hast thou seen!  
There, where the long street roars, hath  
been  
The stillness of the central sea."

The shells of yet another race of tiny sea animals are found in vast numbers in the old rocks of Bermuda and Barbados, as well as in Richmond, Virginia, and many other parts of the world. These "Radiolaria" (rā'dī-ō-lī'rī-ā), as they are called, are most abundant in the tropic seas, where great tracts of the ocean floor are covered with deep layers of their tiny, flinty skeletons, all blended together into a soft, oozy mud—called radiolarian ooze. They are quite as interesting as the

Foraminifera and, perhaps, even more beautiful. Their wee transparent bodies glow with rich tints of crimson, yellow, or blue, and their little skeletons are like exquisitely carved stars, spiked helmets, bells, and coiled shells, all beset with the long, radiating spines which have given these creatures the name of Radiolaria.

In comparison with the Forams and the ray animals the Noctiluca (nōk'ŭ-lū'kā), another quaint little sea dweller, is a positive

giant, although actually it is hardly bigger than a period on this page. It is a funny-looking little thing, like a wee, blown-out bladder or an air bubble, with a dent in one side which gives it somewhat the shape of a peach. In this dent is the creature's mouth, through which it sucks in its food, consisting of fragments of water plants so small that they are quite invisible to our eyes. A short lasher, like a funny little tail, projects from one side of the mouth; with this the Noctiluca vigorously thrashes round in the water and so jerks itself along. In warm, summer weather millions of these odd little animals crowd together at the surface of the sea not far from the shore. They are sometimes so abundant that they color the water, giving

it the appearance of tomato soup. A still summer night is the best time to see these small wandering sea folk. Then every little Noctiluca is transformed from a bag of dull reddish jelly into a tiny fairy lamp glowing with a soft blue or greenish light that comes and goes as the wee creatures jostle and bump against one another in the water. They cause the waves to flash and sparkle as with fire.

This strange power of illumination that Nature gives to certain of her children we know as luminescence (lū'mī-nēs'ēns). Such light is without heat. Not one of the little creatures that flaunt their bluish fire ever gets tail or toes burned by it. The glowworms, the fireflies, and all the luminous creatures that live in the sea light up their lamps as safely as you and I may push an electric button. And considering their size, what a vivid light it is!

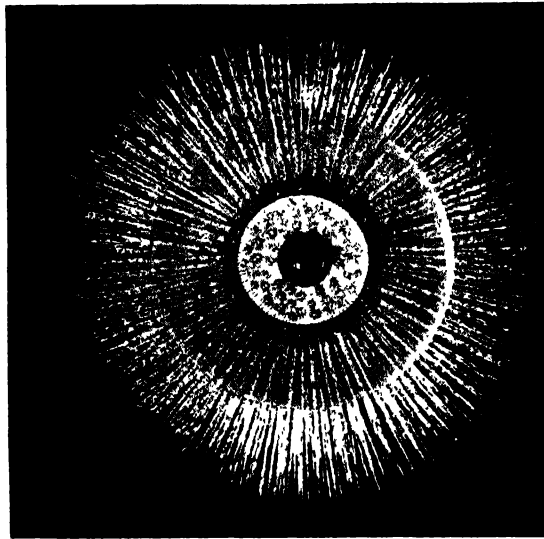


Photo by American Museum of Natural History

Here is another of the beautiful and varied Radiolaria.



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# *The STORY of LIFE in the SEA*

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## Reading Unit No. 2

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### ARE SPONGES PLANTS OR ANIMALS?

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

What sponges really are, 3-82-83  
How sponges eat, 3-83  
How a sponge protects sea animals, 3-84  
The adventures of a baby sponge, 3-84

The size of sponges, 3-84-85  
Kinds of sponges, 3-85-86  
A sponge that bores holes in rocks, 3-86  
How sponges are collected and prepared for our use, 3-87

#### *Things to Think About*

Why do we believe that the sponge is not a plant?  
How does the sponge capture its food?  
What protects the jellylike bodies of sponges?  
How are other animals protected

by sponges?  
Why is one sponge called "Neptune's cup" and another "Venus' flower basket"?  
How do people "fish" for sponges?  
How can we "farm" sponges?

#### *Picture Hunt*

What is a famous shipping center for sponges? 3-82  
How are sponges dried? 3-83  
What benefits do the sponge and crab give each other? 3-84  
What part of the sponge is shown

in this picture? 3-85  
What is beaten out of a sponge when it is prepared for use? 3-86  
How are sponges brought up from the sea? 3-86

#### *Related Material*

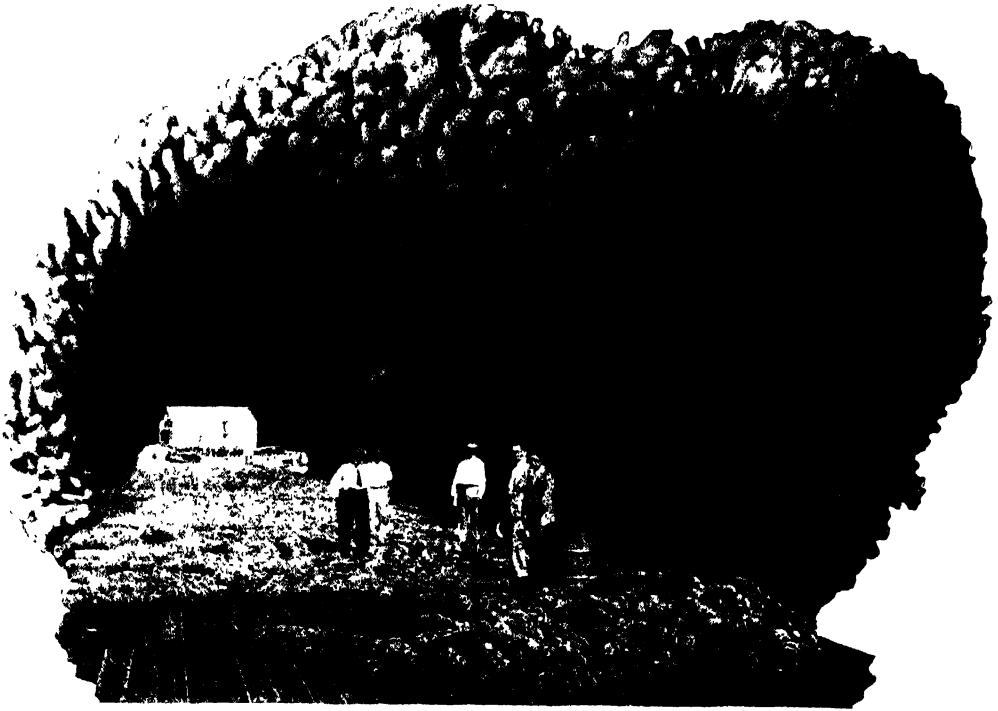
How do the natives in the Bahamas gather sponges for the market? 7-53

How far back in history do we find sponges? 3-9

#### *Summary Statement*

Sponges, when they reach us, are the skeletons of soft, jellylike sea animals. Men go down in the sea in special diving suits or without them to tear the sponges from the rocks to which they cling. Then the sponges are dried in the sun and the soft material is beaten out with a mallet. There are many kinds of sponges.

Some sponges drill holes in oyster shells or in limestone cliffs. Others get nourishment by sucking sea water into their cavities, where oxygen and food particles are absorbed. Some sponges are giants with shapes and substances that suggest names used in mythology.



Where will all these sponges go and what will they be used for? Here they are, at Tarpon Springs in Florida, about to enter on a busy life. The sponge that forms

the background is really a separate picture and is life-size. You can see that the ones laid out to dry are at least twice as large.

### ARE SPONGES PLANTS OR ANIMALS?

*Before You Read Any Farther, Stop and Make a Guess as to Where the Humble Sponge First Came from, and What Sort of Thing It May Be*

**T**HERE is so much to be seen in the world under the sea that if, like the little sea-maid, we were able to wander as we pleased under the water, every moment would be full of excitement. When tired of roaming, we might sit down and rest a while on one of the soft, mossy-looking cushions that cover many of the rocks round about. Here we could watch some of the strange sea folk moving here and there—all very busy with their own affairs.

But things are so perplexing in the salt-water world! Many of the animals are so strange that it is not always easy to recognize them when you do see them. For instance, the very cushions on which we are

seated are not made of moss or seaweed or any other kind of plant; they are colonies of sponges—curious creatures belonging to the animal world.

For a long time people could not make up their minds about these puzzling sponges. Some thought they were plants and called them seaweeds, sea mosses, or sea mushrooms; others believed them to be masses of solidified sea foam; others again declared they were nests made by sea worms to shelter themselves from their enemies. But they were all wrong. Though an ancient philosopher named Aristotle suspected the fact, it was not until almost the middle of the eighteenth century that a learned professor,

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by carefully watching the behavior of some tiny sponges under the microscope, proved that they were really animals.

If you look at your big bath sponge, which is really the skeleton of the animal, you will see that it is full of holes—numbers of small ones with a few larger ones scattered here and there. These holes are the breathing pores of the sponge. They open into a network of tubes, or canals, all connected and leading down into small, hollow chambers in the animal's interior.

Now when the bath sponge was alive under the sea, water was constantly being sucked in through the smaller pores; after circulating through the canals it flowed out again through the large holes. The walls of the larger canals are lined with long, fine hairs that lash the water with great energy, sending it streaming along up and down the tunnels and then out again through the larger openings, from which it gushes as if from a number of little fountains. The currents of water as they flow in carry particles of food to the sponge and bring the fresh supplies of oxygen needed by the animal to keep it healthy. After working away energetically for its living for some time, the sponge grows tired; so it closes its pores while it takes a little rest and digests its food. But soon all the

pores are opened again, the streams of water rush in once more, and the fountains begin to play.

Bath sponges and all toilet sponges are found in the warmer seas, the finest kinds coming from the Mediterranean and West Indian seas. They are called "horny sponges," as the soft, elastic "spongin" of which their useful skeletons are formed is somewhat horny in texture.

Other sponges have their spongin skeletons strengthened with a mass of tiny spikes, called spicules (spīk'ūl), and some have no spongin skeleton at all. Their soft, jellylike bodies are supported entirely by a network of these sharp little needles.

The spicules are formed by the sponges themselves from materials which they extract from the sea water—just as the Forams extract the lime for their tests. They are beautiful little objects, though so small that we can see their shapes only under a strong magnifying glass. Some are like fine, sharply pointed needles. Others are like stars, anchors, or the ancient flint weapons used by the half-wild men of bygone ages.

These sharp little spicules make a mouthful of sponges very prickly, not to say painful; so most sea



Photo by American Museum of Natural History

These curious spiny things are sponges too. They grow with the small end fast to a rock, and like all toilet sponges, belong to the group known as "horny" sponges.



Photo by U. S. Dept. of Fisheries

Here are the sponges drying in the warm southern sun—only one of the stages on their way from ocean bottom to bathroom or garage.

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creatures in search of a meal leave the sponges severely alone. Most sponges, too, have such a very disagreeable smell that hungry, prowling sea folk usually give them a wide berth. Now certain little animals, such as various kinds of sea worms, wee crabs, and even small fishes, take advantage of this and actually make their homes inside the sponges. There these amusing little uninvited guests live contentedly, quite safe from their enemies, and calmly help themselves to the food carried into the sponges by the inflowing currents of water.

Many of the larger sea creatures, too, hide themselves away under living sponges, making use of them as shields to ward off the attacks of disagreeable neighbors. Some of the funny, long-legged spider

crabs actually disguise themselves by planting bits of sponges all over their backs and legs. Another, called the "sponge crab" or the "sleeping crab," holds such a large mass of sponges on its back that they spread out all around him like a cloak. This effectually hides the sleepy fellow from view when he lies still and dozes away his time, as he is so fond of doing. Hermit crabs are fond of choosing whelk shells on which sponges are growing for their homes—the better to conceal their soft, tempting bodies from hungry sea animals.

A sponge spends all its life fixed to one spot—all, that is to say, except for a very short period in its youthful days. When a

baby sponge first leaves the little nursery cell inside its parent, it is nothing more than a wee jelly bag surrounded with fringes of finest hairs, called cilia (sil't-ä). These fringes act as paddles, enabling the little creature to paddle its way about in the water. For a short time the young sponge leads a roving life, swimming merrily here and there just as it pleases. But this free and easy time does not last long. The young sponge soon grows tired of a restless life, and, if it escapes being gobbled up by a hungry fish, it sinks to the bottom of the sea and settles down on a rock or a stone or a shell, or anything firm and solid it may chance to alight on. There it remains for the rest of its days and never wanders again.

There are sponges of all sorts of shapes and colors and of all sizes, from tiny things no bigger than a pin's head to huge masses weighing over a hundred pounds.

They grow nearly everywhere in the sea, though the larger and finer specimens are found in warm tropical waters.

They live in rock pools, in shallow water, and in deep water. They cover rocks and stones with cushions of

orange, yellow, pink, lilac, gray, or blue; they spread soft carpets on the floors of caves and grottoes under the sea, and festoon the walls with wonderful tapestry of many colors.

These great sponge masses are not just one single sponge, but a whole colony of animals growing side by side. For many sponges increase in size by "budding," much as plants do. Sometimes the buds break off and float away but sometimes they stay and



Photo by American Museum of Natural History

Here are (1) a cactus sponge and (2) the curious "glass rope." Imagine the second as growing gracefully at the end of its glassy stalk, which is sometimes a yard or more long.



This spider crab is a timid fellow, so he plants a sponge on his back and masquerades under it all his life. It is as if you were always carrying green branches about to make people think you were only a tree.

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grow on the spot—all joined one to another. If we look carefully at one of these spreading sponges, we see that it is composed of a number of little hollow mounds, like a range of tiny volcanoes. Each little mound is probably a separate sponge, but they are all so closely joined together that it is not always easy to determine exactly where one individual ends and another begins.

Sponges do not all grow in massed formation. They take all sorts of different shapes. Some are round as balls, others are like tubes or vases. Some sponges are cup-shaped. Others grow like branched candlesticks or spreading trees. We may often find some of the smaller sponges growing on the seaweed cast up on the shore. Others are fixed to stones, old wooden piles, and breakwaters, or to the under side of overhanging rocks that are washed by the waves when the tide is high. These are usually rather dull in color and are simple little things, like tiny sacks or bunches of tassels. In the deep rock pools, these simple sponges grow rather

bigger and are often brightly colored or snowy white. But for the largest and most wonderful specimens, we must go far out to sea and dive down in deep water.

One of the finest varieties of all is called "Neptune's cup." It grows on the coral reefs in the Indian Ocean and is a real giant among sponges. It is shaped like a huge goblet, sometimes five feet high—a fit glass for the old sea king to drink from.

Then there is the glove sponge, the cockscomb, the velvet sponge, and the lappet sponge, which grows in large thin flaps like elephants' ears. All these live in the waters off Florida, the Bahama Islands, and the West Indies. Their names describe them fairly well.

Most wonderful of all are the Japanese

glass-ropesponges; the lace sponges, and one called "Venus' flower basket," found in the seas off Japan and the Philippines. The glass-rope sponge has a cup-shaped body, rather soft though crisp to the touch. It is fixed to the end of a long stem, which sometimes measures as much as a yard and looks as if it were made of twisted strands of spun glass. This rope is really the root tuft, composed of extraordinarily long glassy spicules, by which the sponge firmly fixes itself in the mud at the

bottom of the sea. Japanese fishermen fish for these sponges with special hooks fixed to their deep-sea shark lines. When some of the "glass ropes," without the sponges themselves attached to them, were first sent over to Europe people

thought they were curious ornaments made by clever workmen in the Far East.

But Venus' flower basket is perhaps the most beautiful of all the sponges. It is shaped like a gracefully curving horn, and its glassy white skeleton looks just as if it were made of the most exquisite basket work.

Quite a different kind of animal is the curious little Cliona (klí'ô-ná), or the boring

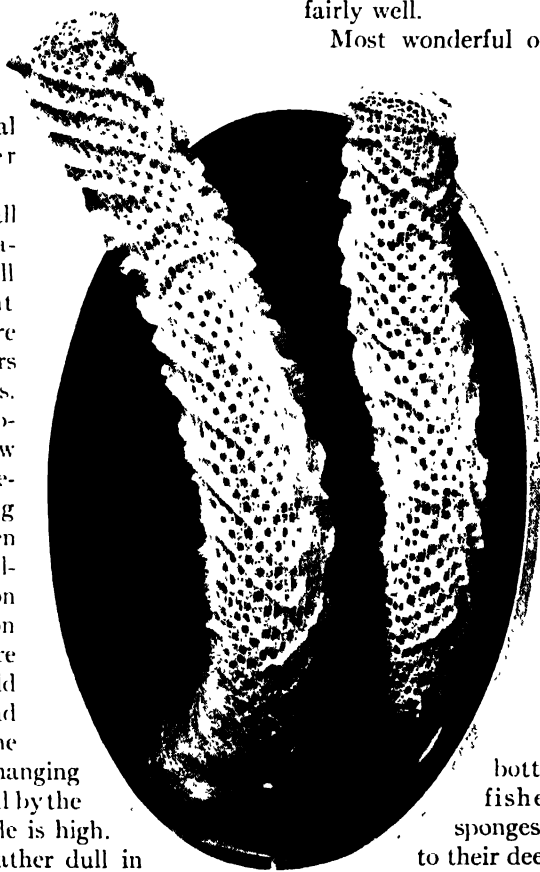


Photo by American Museum of Natural History

Can you think of a prettier name for these sponges than "Venus' flower basket"? They grow as long as eighteen inches, and in life their glassy skeletons are covered with brown flesh.

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## THE STORY OF THE SEA

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Below: Sorting  
sponges.



Left: Beating the  
sponges clean.  
Right: The diver's  
difficult work.

Above: Packing for  
shipment.

These four pictures show some of  
the adventures of a sponge on its  
way to market.

sponge. It is not much to look at—just a tiny, wormlike creature with a soft body that no one would ever guess could be of any importance whatever. Yet this queer little thing is sometimes a terrible nuisance. It often does considerable damage by boring into oyster shells and limestone cliffs—though exactly how it manages to do this no one yet has been able to find out.

### Sponges That Tunnel through Stone

One may pick up on the shore pieces of limestone that have been riddled through and through by these tiresome little sponges; and cliffs are sometimes so honeycombed by their winding tunnels that they actually crumble away.

Cliona is fond of resting just at the entrance of its burrow, where it looks like nothing so much as a tiny yellow pimple on the rock. But touch it ever so gently, or even tap lightly on the rock in which it has

made its home, and the funny little sponge hastily backs into its tunnel and disappears from view.

### Sponge Fishing

The sponge fishery is one of the most important industries of the sea, giving employment to many thousands of people who collect the sponges and prepare them for market. Until the middle of the nineteenth century, sponges were obtained chiefly from the waters of the Mediterranean; but in 1849 important sponge fisheries were started on several parts of the American coast. Most of the useful kinds, employed for cleaning machinery, washing windows, and hard work of that sort, now come from Florida and the Bahama Islands. Tarpon Springs, Florida, is the greatest shipping center for sponges in the world.

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## THE STORY OF THE SEA

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Painted Especially for This Work

Here are some of the countless beautiful things that make the sea floor like a garden. It is as if Mother Nature had taken the gayest colors on her palette and

had said, "Now I have a beautiful background of green and blue water and soft yellow sand. Anything will look well against that." And anything does!

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## THE STORY OF THE SEA

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Painted Especially for This Work

*You may think this undersen garden too highly colored to be true to life. But if you could see them growing, these strange sea anemones would seem even more vivid and unreal. Their snaky tentacles*

*would sweep gracefully about, their stout bodies would grow long or short before your very eyes, and any unwary little fish that chanced to come too close would be wrappd about with those long arms and suddenly disappear.*



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In shallow water sponges are often torn from the rocks with long-handled, pronged forks, but this rough treatment is apt to spoil the sponges and make them of small value. In deeper water they are collected with a special kind of dredge, or are gathered from the bed of the sea by expert divers. Dressed in full diving costume, these men

sheep's-wool sponges, the grass sponges, and the glove sponges. From the Mediterranean come the turkey cup, the honeycomb, the lappet sponges, the hard sponges, and the common horse sponges. In Egyptian waters native divers often plunge into the sea without a diving dress, clasping a marble slab weighing some thirty pounds. This heavy



A forest of spars and an acre of sponges—and plenty of leisure, it would seem, for drying and sorting and

packing the strange yet useful animals under a southern sun, before sending them out across the world.

descend from boats and walk about under the sea, plucking the sponges from the rocks with their hands and packing them into large net bags. When the bags are full the divers signal to the men in the boats above them and are then pulled up.

After they are taken from the water, the sponges are left for a time until the soft, living tissues with which the skeletons are covered begin to dissolve away. They are then washed and beaten, threaded on strings, or placed on wooden racks to dry in the sun. Some sponges are afterwards bleached with chemicals; although this makes them look attractive they are not so strong as those that have been simply sun-dried.

The most important sponges found on the coasts of Florida and the Bahamas are the velvet sponges, the yellow sponges, the

weight quickly carries the diver to the bottom, where he stays for two or three minutes collecting as many sponges as he can. Then he signals by jerking a lifeline attached to a ring on his arm and is hauled up to the surface, leaving his slab to be pulled up after him.

In Florida sponges are sometimes grown from "cuttings"—for when a sponge is cut up, almost all the pieces will live and grow if they are put back into the water. The pieces of sponge are strung on wires and suspended between posts in shallow water, or sometimes they are nailed down on slabs of cement, which are placed in the sea. In about six months' time, most of the fragments will have grown into quite good-sized sponges, nearly six times as big as when they were planted.

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# *The STORY of LIFE in the SEA*

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## Reading Unit No. 3

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### ANEMONES, THE BRIGHT "BLOSSOMS" OF THE SEA

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Where you can find sea anemones, 3-89  
Why some rock pools look like rock gardens, 3-89  
How the anemone hunts for and eats its prey, 3-90  
The poisoned darts of an anem-

one, 3-90  
The color and size of anemones, 3-91  
How to capture and keep an anemone, 3-91-92  
Partnerships between fish, crabs and anemones, 3-93-94

#### *Things to Think About*

How does a sea anemone use its tentacles?  
How are small animals paralyzed when caught by an anemone?  
What prevents an anemone from

being torn from its rock?  
How can sea anemones act as bodyguards for hermit crabs?  
How are anemones born?

#### *Picture Hunt*

What can an anemone do with its length? 3-90-92  
Why are anemones sometimes called "undersea flowers"?  
Color plate 3-94

Why do fish hide inside the giant sea anemone? 3-91  
Of what advantage to an anemone is its perch on a hermit crab? 3-93

#### *Related Material*

How does a lichen illustrate the same sort of "living-together" as do the anemone and crab?

2-58  
What is the meaning of the term "symbiosis"? 2-58

#### *Leisure-time Activities*

PROJECT NO. 1: If you live where anemones can be found, fill a tank with salt water from the ocean and after finding an anemone, place it in the tank.

Observe its habits. Include some tiny crabs and fishes in the tank for food. Cover the tank with a sheet of glass to prevent evaporation of the water, 3-92

#### *Summary Statement*

Sea anemones are among the most colorful of all sea animals. Their many tentacles wave about in search of food. The prey is stung to death with the poisoned

darts shot out from the tentacles, and then the food is put into the central hollow or stomach to be digested.



This is the kind of boat and the kind of racy old salt that bring us our fish to fry. He can take a squint

at the sky and tell us just what the weather will be, and he is as much at home on the sea as on dry land.

## **ANEMONES, THE BRIGHT “BLOSSOMS” of the SEA**

*The Anemones That Grow in the Sea’s Green Gardens Can Walk from Place to Place and Have an Exceedingly Strange Taste in Food*

**T**HE beautiful flowerlike sea anemones (â-nēm’ô-nē), like the sponges, pass their lives securely fixed to some solid foundation, though they are not quite so permanently attached. They do move sometimes. If an anemone is not satisfied with its position in life or if it grows tired of staying in one place, it moves its house by gliding slowly on its broad foot along the rocks until it finds a spot that suits it better. Occasionally an anemone, greatly daring, will let go its hold on the rocks altogether and set out on a voyage of adventure, letting itself be carried away by the currents. After drifting about for a bit, it finally comes to anchor on fresh ground. So anemones do see a little more of life than the stay-at-home sponges do.

Although a few anemones live in deep water, most of them prefer quiet bays and shallows and the rock pools near the shore. Some even fix themselves to rocks and boulders which are left high and dry when

the tide is out. So when we are staying at the seaside, we may be lucky enough to see some of these pretty sea creatures in their watery homes without having to venture far out to sea.

If we peep into a clear rock pool where a number of anemones are growing side by side, we shall see a most wonderful sight. The pool looks like a beautiful rock garden filled with gorgeous flowers of every hue. Here, instead of bees and butterflies, shrimps and little fishes dart about among the gayly tinted blossoms, and in place of active beetles funny little crabs scuttle over the ground.

But just watch for a while. Somehow the little creatures swimming about do not appear to be quite so happy and secure from harm as one would imagine they should be in the lovely, peaceful pool. Some of them seem to be in difficulties. Look! a small transparent shrimp is entangled in the long, petal-like fingers of one of the larger anem-

## THE STORY OF THE SEA

ones; although he kicks and struggles gamely they hold the little captive fast. He cannot break away from their clutches; closer and closer the soft, brightly colored fingers clasp the poor shrimp. He is rolled to the center of the flowerlike thing, the cruel fingers close over him, and he disappears from our sight. The anemone has swallowed the shrimp! Now it draws in all its feelers and shuts itself up while it rests and enjoys its dinner.

But why did not the shrimp swim away from the anemone? Surely, one would think, it would be easy for such a quick, lively little thing to escape from those soft, clinging fingers. Well, the fact is, the anemone is a fraud. Although it looks so pretty and harmless it is really a very hungry, greedy animal. When its flowerlike head is gracefully swaying from side to side in the water, it is really feeling for something to eat.

Those curling fingers are cunning traps, designed to catch and hold fast any of the thoughtless little sea folk that venture within reach of its clutches.

The smooth, slippery fingers, or tentacles (tĕn'tà-k'l), as they are called, are crowded with hundreds of horrible, stinging threads, somewhat like the stinging hairs of a nettle. You cannot see them. For when they are not wanted, each one of the fine, long threads is kept tucked away out of sight, coiled up

like a spring in a separate little pocket, or sting cell, and held in place by a kind of hair trigger. This little hair trigger is so sensitive that at the slightest touch it springs back, releasing the coiled thread, which immediately jumps out of its pocket like a

jack-in-the-box. So when any small, thin-skinned creature brushes against the tentacles of an anemone, it is instantly pierced and stung by a number of horrid little barbed darts. Its wild struggles only make matters worse, for the poor little captive keeps touching fresh triggers, setting free whole battalions of stinging threads, till "thick and fast they come at last, and more and more and more." At last, overwhelmed by this murderous attack, the helpless victim can struggle no more and its fate is sealed.

These deadly stinging threads are not only armed with sharp, pricking barbs; they are hollow, and contain a poison that actually paralyzes small animals and reduces them to helplessness. When once the threads are uncoiled they cannot be packed away again; but this does not trouble the anemone, for as fast as they are used up new ones are grown to take their place. There is always a plentiful supply of poisoned darts on hand.

There are a great many different kinds of these curious sea animals. They are sure to



Photo by American Museum of Natural History

Here are some of the flowers that bloom in a garden under the sea. They are all anemones—and they all are living creatures. One of them has started creeping about to find a new place to live. His stay-at-home brother has drawn himself up and looks very short in comparison, though they really are both full-grown. Of course you must let your imagination color them the most brilliant tints; and you must not forget that the stones in the picture are not great boulders but only little pebbles.

## THE STORY OF THE SEA

be found in the shallow waters of almost every coast, wherever there are rocks to cling to and to offer shelter from rough seas; for anemones prefer a quiet life and hate being buffeted about by boisterous waves.

### Acrobats in the Sea

The finest and most gorgeous anemones live in the warm, tropical or subtropical seas, where some, when expanded, are as large around as a dinner plate. Far down in deep water, where they are quite undisturbed, there are a few giant anemones as big as bicycle

until they are very tall and thin, then suddenly sink down and become short and portly. They will blow themselves out with water till their skin is as tight as a drum, then gradually empty themselves so that they collapse like a pricked balloon and are almost as flat as pancakes. They can lengthen or shorten their tentacles just as they please; and the moment they are startled they draw them all in and turn themselves into a slippery lump of jelly!

An anemone is a very simple kind of animal, almost

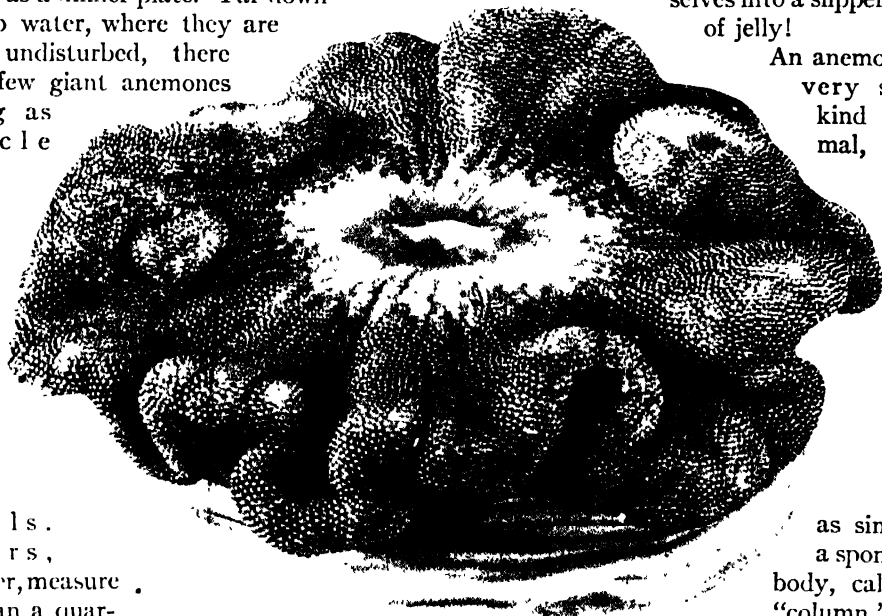


Photo by American Museum of Natural History

This is the giant sea anemone. He lives on the Great Barrier Reef of Australia, and grows to be as much as twenty inches across. In life he is a beautiful fellow, with soft brown and blue body and salmon center. The hole in the middle is the creature's stomach. In it there always live a beautiful little fish and a prawn. If you thrust in a stick they dart out, but at the first chance they hurry back home again.

wheels. Others, however, measure less than a quarter of an inch across their pretty little flowerlike faces, and are no bigger than a green pea when they tuck in their tentacles and shut themselves up. They are all sorts of colors—pink, red, blue, purple, lilac, orange, yellow, brown, gray, snowy white; in fact, they are almost any shade you can think of. Some are the same color all over, others are gay with spots and bands of contrasting hues. Some anemones hold their heads proudly aloft on long, slender stems; some are short and plump. Their tentacles may be like long, shaky feelers, soft feathery plumes, the petals of a flower, or like short, stumpy fingers. They are wonderfully elastic, too, and can alter in shape. Some anemones stretch themselves

as simple as a sponge. Its body, called the "column," is just a hollow tube divided into several compartments, with a little sack, open at both ends, in the middle.

This sack is the anemone's stomach. At the top of the column is a flat, circular disk with the tentacles radiating from it. In the center of this disk is an opening, rather like the slit in a letter box. This is the mouth of the anemone.

### A "Sea Flower" Will Not Be Plucked

The base of the column branches into a kind of foot, with which the animal grips the rock so tightly that it is of no use trying to pull it off. For the anemone has a will of its own. It simply will not let go. It would sooner allow itself to be torn in two

## THE STORY OF THE SEA



Photo by American Museum of Natural History

These are all sea anemones. It is easy to see why the great writhing fellow above at the right should be called the "snake-lock" anemone. There are at least two hundred of those snaky tentacles. He stretches himself out only at night, when he reaches a length of four or five inches. During the day he draws himself in, like his companions in the same picture.

than give up the tussle in a tug-of-war. The only way to get the better of an anemone is to peel it off its base—and then it would probably be injured. Really, the only safe way to transfer an anemone from a pool to an aquarium is to take the rock too—if you can!

### Dainty Anemones and Greedy Ones

However, many anemones attach themselves to shells or stones, and these, of course, can be moved easily. They will live quite contentedly in an aquarium so long as they have plenty of the right kind of food and water that is kept well supplied with air. For like all living things they must have a constant supply of oxygen or they will soon die.

Some anemones are very dainty creatures, caring only for the finest broken fragments

of food floating in the water, or the tenderest of baby fishes. Others will eat almost anything and clutch at everything dead or alive that comes within reach of their tentacles. Sometimes a greedy one will eat so much that it is quite swollen with food; or it may swallow something that disagrees with it. Then the poor thing looks most uncomfortable and appears to suffer badly from indigestion.

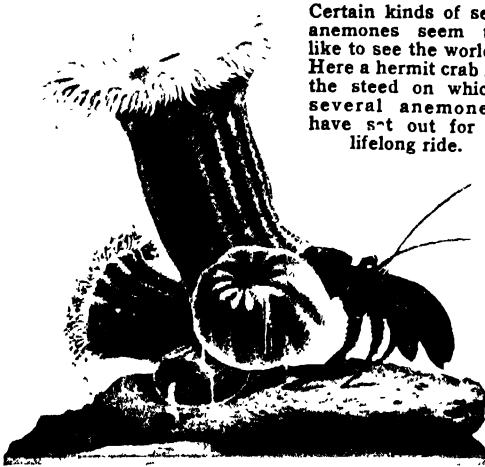
### Odd Habits of the "Sea Flowers"

Even such simple creatures as anemones have their peculiarities. They do not all behave exactly in the same way. Some are nervous, startled by every shadow or movement in the water, and are always shutting themselves up in a hurry. Others are restless and are constantly on the move, swaying from side to side, jerking their heads this way and that, and waving their tentacles about.

Some anemones prefer to live in caves

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where the light is always dim. Others are fond of soft sunshine; so they make their homes in the rock pools or in open water. Some, instead of clinging to rocks and stones, bury themselves in the sand or tuck themselves away in holes in the rocks; only their tentacles can be seen waving about in the



Certain kinds of sea anemones seem to like to see the world. Here a hermit crab is the steed on which several anemones have set out for a lifelong ride.

Photos by American Museum of Natural History

water when the anemones put their heads out of doors to fish for their dinner. So shy are these little cave dwellers that they shrink back out of sight at the very first sign of danger. The tentacles of the sand anemones are so coated with sand and tiny stones and little bits of broken shells that they are almost invisible; it is only when they move that we can see them at all.

### Gypsies of the Sea

Then there is the wandering anemone, who never settles down at all but floats about near the surface of the sea upside down, with its tentacles trailing in the water. The foot of this odd little creature is curled round to form a small balloon and is filled with gas; so it acts as a buoy, preventing the anemone from sinking to the bottom of the sea.

Another anemone with a taste for adventure perches itself on an old whelk shell inhabited by a hermit crab. When the hermit crab ambles around in search of food, dragging his house about with him, the anemone enjoys a free ride.

These two strange companions are quite good friends. The hermit appears to have

no objection to being used as a kind of triumphal car. In fact he seems to like it, for as he trundles about, the waving tentacles of the anemone on his back are useful in warding off the attacks of his enemies. They may, perhaps, save him from falling a victim to a hungry dogfish. For dogfish are very fond of crabs for dinner and will often make a meal of a hermit in spite of the shell in which he hides. As for the anemone, it has a very good time. It is carried in state from one place to another and enjoys many a free meal. Every time the hermit finds something good to eat and proceeds to tear it in pieces with his claws, in the usual crab fashion, the anemone sweeps up with its tentacles the odd fragments scattered about and joins in the feast.

### A Queer Coat for a Crab

The hermit's companion is called the "parasitic (pär'ä-sīt'ik) anemone." But this is hardly fair. A parasite (pär'ä-sīt), you know, is one who lives at the expense of another and gives nothing in return for the favors it receives. This cannot be said of the friendly little anemone. It does no harm to its lifelong companion and more than earns its keep by shielding the hermit from the sharp eyes of hungry sea ogres on the lookout for something tasty for dinner.

The parasitic anemone is not the only one of its kind to enter into partnership with a

It is hard to realize that the sea anemones below might well be pictures of the same individual. The big one is hungry and is angling for food. The short one has just been frightened and has made himself as small as possible.



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He is a knowing fellow, this little Melia crab. One might think he had a passion for flowers, since he always carries a bouquet in each hand! But wait till

a morsel of food comes by, and you will see that his pretty anemones serve quite a different purpose. They are provision merchants to the little crab.

hermit crab. Another, called the "cloak anemone," is always to be found living on a large shell inhabited by the "blue hermit." This anemone is brown with light pink spots and has a very broad spreading foot, which often completely envelopes the shell in its folds. Its tentacles surround the opening of the shell like a handsome fluffy frill. Sometimes the blue hermit will dispense altogether with a shell and simply wear an anemone wrapped round him like a cloak!

"Curiouser and curiouser," as Alice said, is the behavior of a small tropical crab that lives on the shores of the Indian Ocean. He passes his time promenading about, holding a small anemone in each of his big claws, just as if he were carrying a couple of bouquets! The funny little fellow cannot bear to be parted from his precious anemones. If they are taken from him by force he will run about in a great state of agitation, hunting for his lost treasures. If he finds the anemones, he joyfully seizes them again and sidles away, bearing his living bouquets in triumph before him.

The captive anemones are really most use-

ful to this odd little crab. Not only do they act as a shield and save him from the jaws of hungry fishes—for sea folk do not like anemones and seldom attempt to eat them—but they actually provide their owner with most of his food. Of course, they do not do so intentionally. When an anemone captures a shrimp, a baby fish, or anything else good to eat, the crab calmly picks the dainty off its tentacles and transfers it to his own mouth. He uses his

first pair of long, slender walking legs for this purpose, as never for one moment will he open his big claws and run the risk of losing his useful friends.

Now when we know how dangerous it is for small sea folk to venture within reach of the deadly, stinging tentacles of an anemone, it is positively bewildering to find that two or three little creatures actually live safe and sound right inside some of the larger kinds.

A large, gayly colored prawn, a small crab, and at least two odd and gaudy little fishes, are all taken in as lodgers by some of the giant anemones found living on the Great Barrier Reef of Australia. One of these



Photo by American Museum of Natural History

What a thriving business any seedsmen could do selling the seeds of a flower like this sea anemone!



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## THE STORY OF THE SEA

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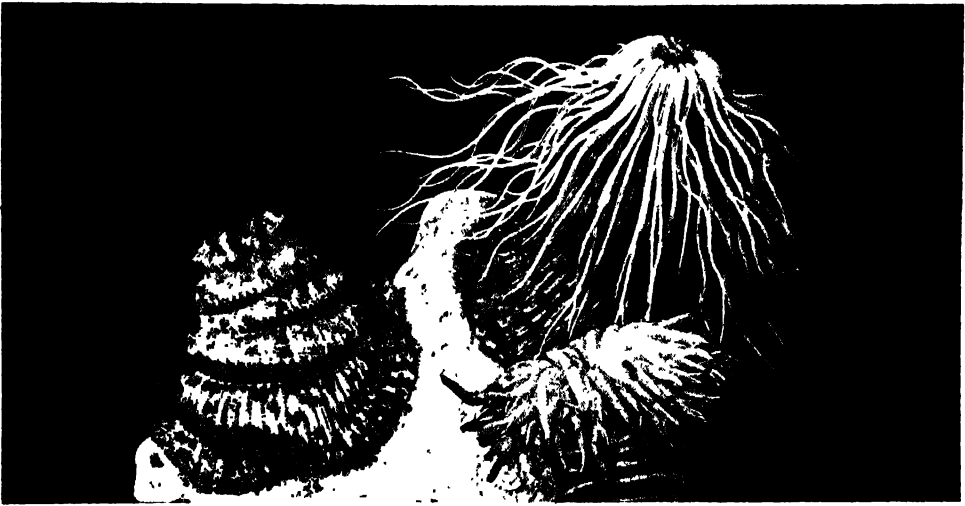


Photo by American Museum of Natural History

**Nature never seems to run out of ideas. Here she has dressed her anemones in beautiful frilled skirts.**

fishes is a startling orange-red color, its fins are edged with black, and round its little body are several pearly white bands with black borders. The other fish is just as brightly clad but has only a white band round its head and cheeks, which makes it look as if it were suffering from toothache and had its head tied up in a bandage.

Both these fishes swim gayly about among the tentacles of their own particular anemone and dive right into its mouth if anything startles them. When the alarm is over, they reappear quite unharmed.

Why these fishes escape when others of the same size are caught and devoured by the anemones no one seems to know. But there must be something unusual about them. Perhaps they are distasteful, and the anemones know it and do not attempt to eat them; or the skin of the fishes may have some protection that prevents the poison in the stinging cells from having any effect on them.

Although anemones are often crowded together on the selfsame rock, they are mostly independent, each one living for itself alone and having no connection with its neighbors. Just a few, however, are more sociable in their ways and form small colonies, in which all the members are joined together by a

common base, like a branching root or a flat, spreading foot.

In most cases these strange, flowerlike animals are developed from eggs, and start life as free-swimming little jellylike atoms paddling their way through the water with their fingers, or fine cilia. But sometimes baby anemones stay safely at home, swimming about inside the columns of their parents until they have lost their cilia and grown a ring of tiny tentacles. Then they all come tumbling out through the mouth of the anemone ready to settle down at once in life. There are others who are never children at all, so to speak, for they develop from little pieces that simply break away from the foot of a full-grown anemone.

If left undisturbed, anemones may live for a number of years. As they have but few enemies, they do not so often come to an untimely end as many other little sea folk do. Only creatures with hard, horny jaws can bite an anemone without getting stung; and even then it is hardly worth eating, for it is but little more than a leathery skin bag full of sea water. There is nothing solid about an anemone—no skeleton, no bones, no spicules. When it dies its pulpy body is all dissolved away, leaving no trace of the beautiful, flowery form behind it.

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# ***The STORY of LIFE in the SEA***

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## **Reading Unit No. 4**

### **CORAL NECKLACES FOR ALL THE WORLD**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

How coral animals leave records of their existence, 3-97-98  
How coral polyps inside the colony are provided with food, 3-98-99  
How corals build reefs or islands,

3-99-100  
Kinds of corals, 3-100-2  
How corals reproduce their own kind, 3-102  
Sea fans and sea pens, 3-102

#### ***Things to Think About***

Why is it always possible to find coral remains?  
How are coral reefs made?  
How long is the Australian Barrier Reef?  
Where do we get the red coral

used for necklaces?  
Why are corals given such names as "sea fan" and "sea pen"?  
What coral gives out a bright light at night?

#### ***Picture Hunt***

Why are reefs dangerous to big boats? 3-97  
Is the sea fan coral a floating or stationary coral? 3-99  
What does the presence of tiny

openings in dead coral indicate? 3-100  
What special kind of coral is shown here? 3-101

#### ***Related Material***

Notice the appearance of the human brain in 2-335-37.  
Why is one coral called the "brain coral"? 3-101  
What other animal skeletons used

by man are found in the sea? 3-82  
How have corals served to save ships during a storm? 1-57

#### ***Summary Statement***

Corals are very much like sponges in producing a skeleton around their soft bodies. Even when the animal or polyp dies and disappears, the hard skeleton remains. Corals generally grow

in vast colonies and over a period of years, build up tremendous masses of coral skeletons. Such large masses are called coral reefs or atolls.

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Photo by American Museum of Natural History

A waste of water and barren rock! And yet the Great Barrier Reef along the northeastern coast of Australia is as brightly colored as any garden, for it is made of coral. Green, yellow, orange, red, violet, and purple, the skeletons of countless tiny coral animals have been

piled up to make a reef over 1,200 miles long. It has stood here for untold centuries, for many reef-building corals are very hard and can stand the buffeting of the waves for hundreds of thousands of years. Today their tiny skeletons are a great danger to shipping.

### CORAL NECKLACES *for ALL the* WORLD

*And the Beautiful Coral Is Useful for a Great Deal More than Ornament. It Can Build Up Mountains and Make Great Lagoons Where Whole Fleets May Ride at Anchor*

**O**UR jewels sometimes come from curious sources. Diamonds are but another form of coal; pearls are the "tears" of oysters; amber, the hardened gum from age-old firs; and ivory, the tusk of elephants. The corals, too, that gleam in brooch and necklace, are but the skeletons of tiny animals that, toiling through millions of teeming generations, left us their lovely bones of red and pink and white.

They are close relatives of the sea anemones, and every bit as fragile. But when they die their bodies do not dissolve away, as do the sea anemones'. Instead, they leave their skeletons to help build up marvelous monuments that will last millions of years, a record of the busy life the little creatures led beneath the waves.

Each little "coral polyp" (pŏl'ŭp), as the wee animal is called, is only the fraction of an inch in length. Yet its tiny, practically

indestructible skeleton, added to those of millions and trillions of its fellows, in process of time builds up great rocky reefs and islands.

How do they do it? Well, just imagine a multitude of little polyps like fairy anemones crowded together on a rock, all busily engaged in sweeping the water with the tentacles surrounding their starlike heads. The sea is full of very tiny plants and animals and fragments of all sorts of things good to eat. The polyps work away at a great rate, clutching this invisible food and sucking it down through their tiny mouths.

Now the sea, as we know, contains several kinds of salt in solution. When the coral polyp has extracted all the nourishment from its food, it uses the carbonate (kär'bŏn-ät) of lime it has taken in to form a little platform between itself and the rock on which it is standing. It works away extracting the lime, partly from its food, partly from the

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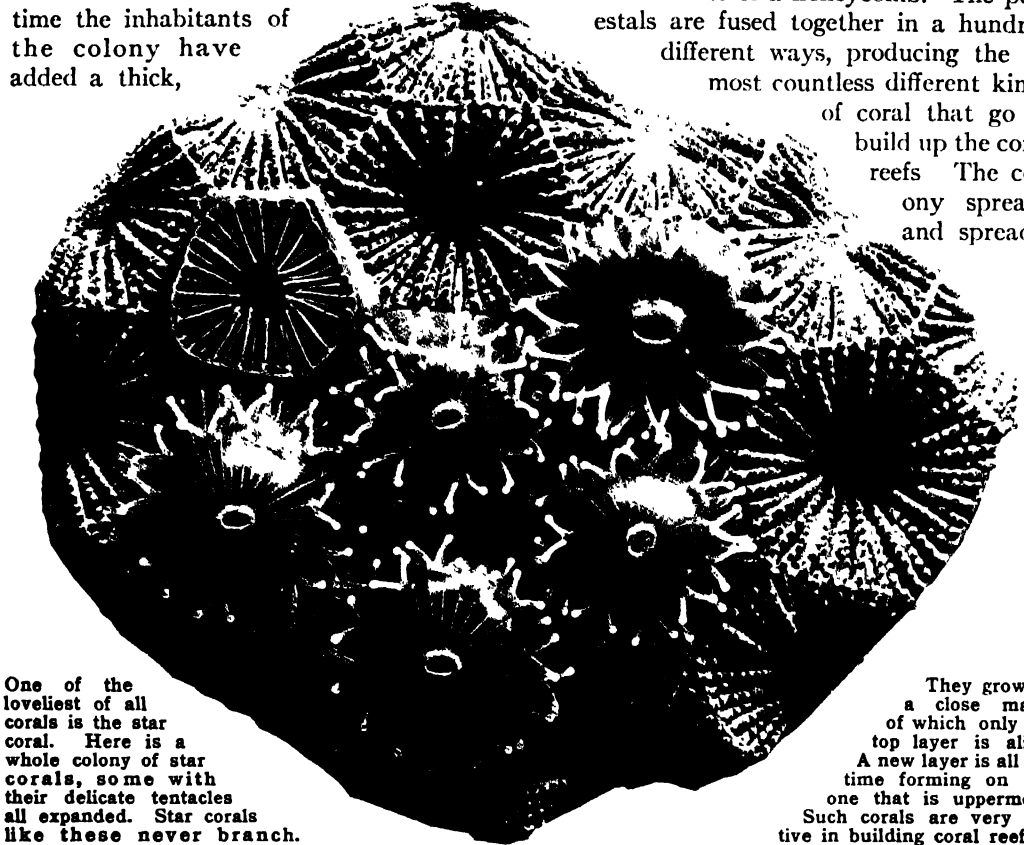
sea, adding layer after layer to its platform, which grows thicker and thicker, until the little builder is perched up on a tiny stony pedestal. Naturally in such a crowded area competition is very keen. Each polyp struggles to raise itself above its neighbors in order to secure a large share of the floating food for itself. So in a short time the inhabitants of the colony have added a thick,

cell is formed by which the frail builder is securely anchored and is in no danger of being swept away by strong currents.

The inhabitants of a coral colony are so closely packed together that all the little pedestals are joined one with another, forming a compact mass of little cells that reminds us somewhat of a honeycomb. The pedestals are fused together in a hundred

different ways, producing the almost countless different kinds

of coral that go to build up the coral reefs. The colony spreads and spreads.



One of the loveliest of all corals is the star coral. Here is a whole colony of star corals, some with their delicate tentacles all expanded. Star corals like these never branch.

They grow in a close mass, of which only the top layer is alive. A new layer is all the time forming on the one that is uppermost. Such corals are very active in building coral reefs.

solid layer of carbonate of lime to the rock—and the foundation of a future coral reef is laid.

The pedestals built by the polyps are not merely shapeless lumps of stone. Each different kind of coral animal works after a particular design of its own, always so perfect and beautiful that it fills us with amazement. The little worker molds the limy material it has extracted from its food into rings and spines and thin dividing walls, building up a wonderful stony skeleton. This is enveloped by the polyp, without, however, breaking the creature's delicate skin. In this way a lovely little cup-shaped

upwards and outwards, slowly but surely; for as soon as a polyp is firmly established in its apartment it begins to throw out buds on all sides. These buds quickly grow into new polyps, which in turn send out more buds—and so it goes on.

### The Crowded Coral Colony

In time the colony becomes so crowded that the polyps in the inner ranks are hemmed in on every side by the ever increasing population. The poor things cannot fish for themselves and would be starved if it were not that, by a system of canals that runs through the whole colony, some of

## THE STORY OF THE SEA



Photo by N. Y. Zoological Society

It might be hard to tell what is living and what is dead in the curious picture above if it were not that the eyes of the "painted eels," or morays, give the creatures away. Then, if you look carefully, you can

make out various corals, among them the "stag's horn" and the delicate "sea fans," which in life are two feet high and have their lacy veins covered with a thin coating of flesh in which the coral animals grow.

the food captured by the polyps living on the outside edges and topmost floors of the building is passed on to their less fortunate neighbors.

### How Tiny Animals Build an Island

Gradually, however, the older inhabitants of the coral colony die out, leaving their tiny chambers empty, while fresh generations of polyps arise to continue the work, adding layer upon layer to the stony pile slowly forming in the water. In due time the huge mass is raised above sea level and a new reef or island appears in the sea.

All this, of course, is not brought about in a few years or even in a few centuries. Long ages have gone to the making of the Great Barrier Reef of Australia, which extends, like a great breakwater, for a distance of 1,250 miles out to sea off the northeast coast of the continent. The Bahamas, that fine chain of West Indian islands first discovered by Columbus in 1492, which stretches for nearly six hundred miles in the

Atlantic Ocean southeast of Florida, took as long to build; and so did all the wonderful coral reefs and islands of the tropic seas.

Reef building coral can live and flourish only in the warmer seas, where the water is crystal-clear and well supplied with air by the constant turmoil of breaking waves. So coral islands, reefs, and atolls (ă-tŏl')—which are rings of coral rock surrounding a beautiful pool of quiet water called a lagoon (lă-gŏŏn')—are most plentiful in the Pacific and Indian oceans. The Bermudas in the Atlantic are farther away from the Equator than any other coral islands.

### Living Gardens of the Sea

The coral polyps are the chief architects of the rocky masses that form the foundations of these reefs and islands. But the work is helped on by multitudes of other sea creatures who contribute their hard shells and skeletons to the ever growing masses of limestone rock. Strange, stony seaweeds.

## THE STORY OF THE SEA

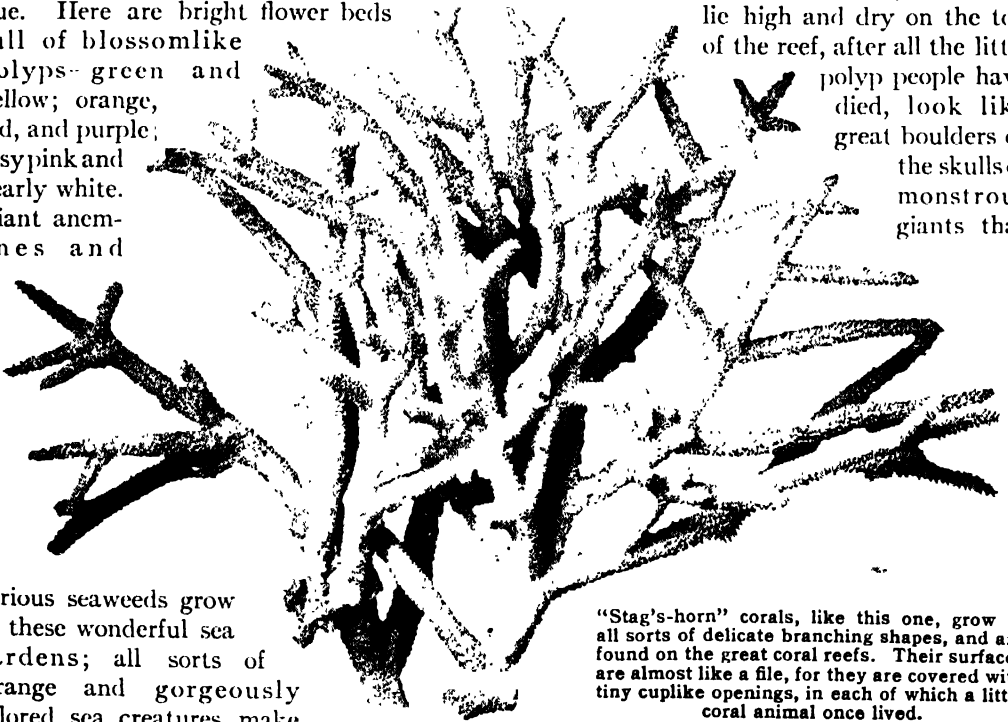
too, grow within the coral colonies and form a kind of hard cement which binds the coral and the loose sand and other fragments firmly together. So step by step the reefs, the islands, and the atolls are built up.

The reefs of living coral are the gardens of the sea, where crowds of busy polyp people grow like magic trees and bushes starred with blossoms of every hue. Here are bright flower beds full of blossomlike polyps—green and yellow; orange, red, and purple; rosy pink and pearly white. Giant anemones and

Chief among the reef-building corals are the stony corals, or “madrepores” (măd'rê-pôr). There are a great many different kinds growing in all sorts of beautiful or extraordinary ways. Some are like bushes, spreading trees, or the branching antlers of lordly stags; others are like bunches of leaves or crinkly fern fronds. The star corals form

large, solid mounds which, when they lie high and dry on the top of the reef, after all the little

polyp people have died, look like great boulders or the skulls of monstrous giants that



curious seaweeds grow in these wonderful sea gardens; all sorts of strange and gorgeously colored sea creatures make

their homes there; and shoals of fishes shining with all the colors of the rainbow dart in and out among the branches of the coral trees. Some even feed upon the coral polyps. Over the reefs the waves of the sea advance and retreat in their unceasing assaults upon the rocks—now dashing over them, tossing their foamy crests skyward in glittering fountains of spray, now drawing back to reassemble their forces for a fresh attack. Great pieces of coral rock are broken off by the breakers and pounded up into pebbles and sand, but the little polyp people enjoy the excitement and commotion in the water and work away faster than ever to repair the damage in the garden caused by the boisterous sea.

“Stag’s-horn” corals, like this one, grow in all sorts of delicate branching shapes, and are found on the great coral reefs. Their surfaces are almost like a file, for they are covered with tiny cuplike openings, in each of which a little coral animal once lived.

have been battered by the waves and bleached by the sun. Then there is the butterfly coral, which grows as a hard stony mass with a beautifully fluted surface supposed to resemble butterflies’ wings. And there is the brain coral, which is covered with wavy ridges that give it a fanciful likeness to a human brain.

The curious shapes of these stony corals are of course more noticeable when the once thriving colonies are dead and only the dry skeletons of their wonderful habitations remain. These tell the tale of the multitudes of active little polyp people who built them up and lived out their little lives within them.

Not all corals live in communities, as the reef builders do. Some, although they make their homes upon the reefs, always remain

## THE STORY OF THE SEA

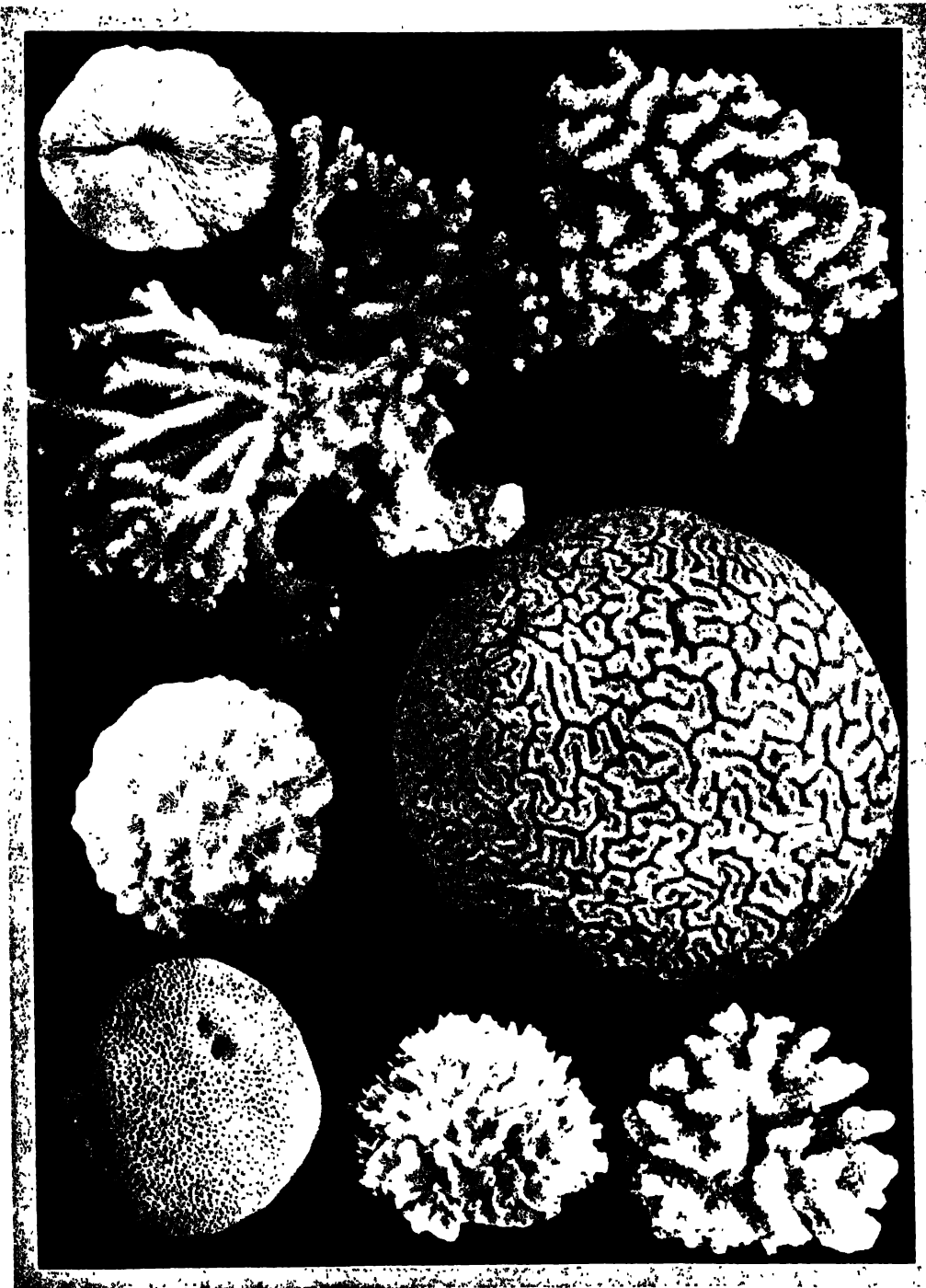


Photo by American Museum of Natural History

These delicate flowers and rosettes are a few of the forms that coral takes. You can easily pick out the brain coral and guess why it is so called. In the upper left-hand corner is a mushroom coral; the branching

forms are madrepores; in the lower left-hand corner is a colony of star corals, with leaf corals on either side. These are all reef-building corals and do not furnish the "precious coral" that we make into jewelry.

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single and have no connection with other members of their families. Many of the solitary corals are quite small, but others grow to a very large size. Some form beautiful cup-shaped skeletons with thin dividing walls all radiating toward the center, like the spokes of a wheel. One, called the "mushroom coral," grows like a little cup and then spreads itself out at the top until it looks exactly like a mushroom turned upside down. After a little while the flat top of the coral breaks off and falls on the sand; but it still continues to grow until it is five or six inches across. Strange to say, the coral stem grows a new mushroom. This in turn falls off too; and so it goes on, until there are numberless stony mushrooms lying around—for all its life through, this strange coral polyp is always losing its head!

Some solitary corals put forth buds, as the reef corals do; but instead of staying at home the buds always break away as soon as they have reached a certain size and settle down to a lonely, independent life.

### How Polyps Multiply

In addition to budding like plants, all corals, so far as we know, produce eggs at certain times in their life. From these eggs come tiny fringed specks of things called "planulas" (plăn'û-lă). These, after paddling about in the water for a while, quietly settle down, grow into coral polyps, and start new colonies or build detached dwelling houses for themselves, according to the usual habits of their own particular family.

### Coral That Gives Us Beads

The precious red coral, from which beads and all sorts of pretty things are made, is not one of the stony corals. It belongs to quite a different branch of the coral family, distinguished by the important name of "Alcyonaria" (ă'l'sî-ô-nă'rîă). Red coral grows chiefly in the Mediterranean. It is a lovely thing, like a bushy shrub or a dwarf Japanese tree, about a foot high. The stems and branches are a deep, rose-red color, and are thickly covered with starry-headed polyps which look like clusters of tiny white flowers.

When the colony is alive the hard red coral stems are covered with a soft skin supporting the delicate flowerlike polyps and connecting them one with another.

### Curious Kinds of Coral

The beautiful sea fan, the deep red organ-pipe corals, and the curious sea pens are all made by coral polyps closely related to the precious red coral. It is easy to tell that they are cousins, as all these little polyp people have the same starlike heads, with eight rays, or tentacles, surrounding their tiny mouths, though they build up their coral houses in entirely different ways.

The sea fans are flat, branching colonies, spreading out like brightly colored fans. They are very flexible, and may be either pink, crimson, scarlet, yellow, or purple. The organ-pipe corals work on quite a different plan. Each member of the community constructs a straight, smooth, slender tube as its own private apartment. The tubes are arranged side by side, standing upright like the pipes of an organ on a series of little platforms, which unite all the polyps in the colony together.

### Sea Pens Like to See the World

Strangest of all, perhaps, are the sea pens, which are quite unlike other corals in their behavior. Instead of fixing themselves to some solid foundation and staying there soberly for the rest of their lives, they float about here and there in the water, roll on the sea floor, or anchor themselves lightly in the sand. They are curious, though very beautiful, like tightly curled feathers or old-fashioned quill pens, and are usually a brilliant red color. This is dotted with white when the little polyps, who live on the outside edge of the pen, put their heads out of doors. The feathery part of the pen is supported on a long stem or foot which can be expanded or contracted; it is sometimes stretched until it is very long and thin and sometimes swollen out like an onion. At night these curious corals shine with a bright bluish light as they rest on the floor of the sea or drift about in the water.



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# *The STORY of LIFE in the SEA*

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## Reading Unit No. 5

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### DAINTY CHILDREN OF THE SEA

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The feathery hydroids, 3-104-8  
Jellyfish that shine at night, 3-107, 111-12  
The Portuguese man-of-war, 3-109-10  
How a jellyfish kills its prey, 3-111

Young jellyfish, 3-112-13  
The comb jellies, 3-113-14  
The "moss animals" or Bryozoa, 3-114-15  
"Policemen" of Bryozoa colonies, 3-115

#### *Things to Think About*

How are hydroids reproduced?  
What causes the "liquid fire" we sometimes see in the ocean at night?  
How are the polyps in a Portuguese man-of-war able to get

food?  
During what time of day are jellyfish usually seen?  
Are large jellyfish dangerous to human beings?  
What do large jellyfish eat?

#### *Picture Hunt*

What kind of animal is the "parasol of the sea goddess"? 3-105  
How can hydroid colonies save the life of a hermit crab? 3-106

What animals produce the cold light in the sea? 3-107  
What enables the Portuguese man-of-war to float? 3-110  
How does a jellyfish swim? 3-111

#### *Related Material*

What other animals give out cold light in the sea? 3-80, 102  
How are sea anemones and jellyfish like each other in the use

of their tentacles? 3-90-91  
What animals other than hydroids are used by hermit crabs for protection? 3-93-94

#### *Summary Statement*

The hydroids are groups of jellylike polyps equipped with stinging darts that paralyze their prey. Colonies of these hydroids are found attached to various objects in the ocean or swimming

free. Umbrella-shaped, hydroid jellyfishes sail the seas and capture food with their tentacles. Many jellyfish give out cold light at night and produce beautiful effects.



It takes a lifetime to learn to know the sea in all its moods; and if you are going to risk your life every

day in a boat's frail bottom, you will need to know how to handle her sail and how to row her, too.

### DAINTY CHILDREN *of the* SEA

*Sea Moss, Sea Firs, and "Fishes" Made of Jelly Are Only a Few of the Strange Creatures That Father Neptune Has Invented to Brighten Up His Watery Kingdom*

**O**NE of the most delightful things to do when we are staying at the seaside is to go treasure hunting on the shore. We follow the ebbing tide, scanning the wet sands and the low rocks as fast as they are uncovered, in search of rare shells and fine specimens of seaweed to add to our collection. We explore the rock pools down by low-water mark to see if we can discover any fresh inhabitants—little ocean waifs that have been carried inshore by the waves and left behind in these miniature water worlds by the retreating tide. And we turn over the tangled heaps of stranded weeds to see what new wonders Father Neptune may have tossed ashore for us to see.

A rocky shore is a capital hunting ground, especially after a storm or a very rough sea, when all sorts of treasures are brought in from the deep water, torn from the rocks and hurled high and dry by the boisterous waves. Among the wreckage, we are almost sure to find some of the pretty, feathery-looking things commonly called "sea firs." In reality they are not seaweeds at all, but something much more exciting, for each of these stiff, plantlike things was once the home of hundreds of quaint little polyp people, closely related to the coral polyps and called Hydroids (hi'droid) or Hydrozoa (hi'drò-zō'ā).

There are a great many different kinds of

## THE STORY OF THE SEA

these sea firs and they are known by all sorts of odd names, such as "sea hair," "squirrel's tail," "sea tamarisk," "sea beard," and "lobster's horn." The names give you



One should try to imagine how these beautiful creatures would look in graceful motion.

Above: Perhaps the handsomest hydroid of all comes from the seas of Japan, where it grows to be twenty-eight inches high and can be stretched to a length of seven feet. In color it is an exquisite pink. No wonder the Japanese call it "the parasol of the sea goddess Otohime."

a fairly good idea of what these strange things look like when you find them thrown up on the shore.

When we pick up the sea firs on the shore, they are already dead and all their beautiful natural coloring is gone. The little polyp town is empty and appears to be nothing more than a dry, yellowish-brown, rather stiff little bush, or a tangled tuft of brown hair. But a sea fir with all its little inhabitants alive and alert, standing erect and swaying gracefully in the currents of water as a tree bends to the soft summer winds, is a very different thing! Each branch of the "fir tree" is crowded with the starry heads of the flowerlike polyp people, each head waving its crown of tentacles from the top of its own little cell, which stands out from the branch in the shape of a dainty, transparent cup or vase.

The little hydroids are very much like their cousins the coral polyps. They are tiny sacklike beings with a mouth at the

top—a head end surrounded by a circlet of sensitive feelers that are forever on the move in the water, ready to clutch at anything good to eat that floats their way. The hydroids' tentacles are just as deadly to any tiny water creature that brushes against them as are those of the corals and the anemones. They are armed with exactly the same kind of stinging hairs coiled up in little stinging cells, all ready to shoot at and paralyze their victim.

The living hydroid colonies are nearly always brightly tinted. The stems and branches on which the polyps live are orange-colored or almost golden, while the polyps themselves

The curious flowerlike hydroid colony below is known as Obelia.

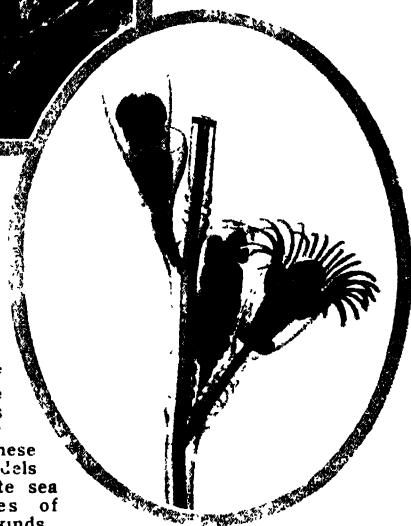


Photos by American Museum of Natural History

The exquisite creature at the left is a hydroid, vastly larger than in life.

Above it is a colony of moss animals, greatly enlarged.

In some of the large museums one may see these glass models of delicate sea creatures of various kinds.



are rosy pink, purple, or lilac. Their little cells are shaped like cups, goblets, vases, or flasks, and are often decorated with fluted or scalloped borders. Some of the cells are always open at the top, but others are fitted with hinged lids that can be opened or shut like a trapdoor, as the polyps pop their heads in and out of their homes.

Each little polyp living in a sea fir has a home of its own and is able to act quite

## THE STORY OF THE SEA

independently. It can stay indoors or stretch its head out of the window, just as it feels inclined, and fish for its dinner without help or hindrance from its neighbors. But like the corals, every member of a hydroid colony is joined to all the others by its foot; when it catches and swallows anything good to eat, the food is actually shared by the whole community. So a sea fir might almost be described as an animal with a multitude of heads, like the hundred-headed Hydra of the old Greek legend.

Some hydroid colonies have polyps so small that you cannot see them at all unless you have a strong magnifying glass, while in others the little animals are nearly as large as field daisies.

Some grow on branches standing straight out all around a central stem, like a bottle brush; on other sea firs the branches are like little fans arranged in corkscrew fashion round the stem. The fine, hairy kinds often form tangled clumps as big as a foot-ball.

A few of the smaller hydroids live near the shore, attached to rocks, stones, shells, or seaweed in the deep rock pools; but they are such delicate, transparent little things that it is not at all easy to discover them. One of the smallest species of all, with stems as fine as hairs, is fond of growing on a shell occupied by a hermit crab; so the wee polyps are carried about and enjoy a constant change of surroundings.

### Trees That Grow under the Sea

The finest sea firs grow in the deeper waters off the coast, where, if left undisturbed, they may develop into sturdy little "trees" nearly a foot high, with a flourishing population of from eighty thousand to a hundred thousand polyp people. Each col-

ony, no matter how large it may be, was originally started by one tiny speck of a thing, a baby hydroid called a "planula" (plăn'û-lă). This settled down on some convenient spot and grew as a plant grows, putting forth branches, after its kind, on which the little polyps unfolded like opening flower buds. Like plants, too, many hydroid colonies lose most of their buds when winter sets in. They fall from the branches like autumn leaves, to be replaced by a new generation of polyps the following spring.



Photo by American Museum of Natural History

This strange affair is a hermit crab, a little sea creature that is too lazy to grow his own shell, and so gets along by sticking his tail into the cast-off shell of some more industrious animal. He makes a useful steed for all sorts of hydroid colonies that fasten themselves on his back and in return for the ride, help to hide him from his enemies.

At certain times of the year several buds of quite a different kind appear here and there upon the branches of the sea firs. They are much larger than the polyp cups and have no opening at all. These big buds are the nurseries of the colony, in which the hydroid children are shut up out of harm's way during the time when they are growing up. The nurseries are as transparent as crystal; so, through a strong magnifying glass, we can see these water babies, tiny saucer-shaped

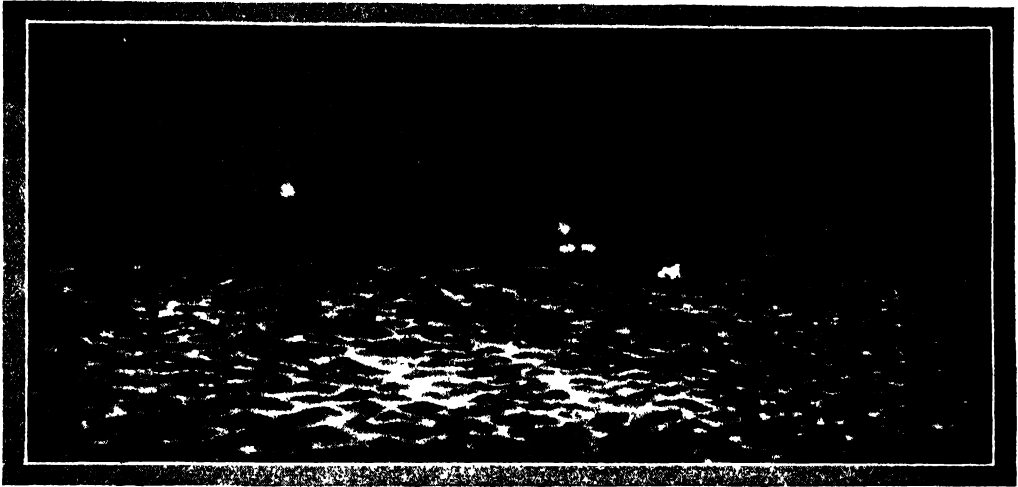
specks of things growing inside. At last one fine day, when the children have grown too big to be kept any longer in the nursery, the buds burst, or open at the top, and the wee creatures come tumbling out into the sea.

One would naturally expect that these young hydroids would be little transparent planulas, provided with swimming fringes as most young polyps are. Well, sometimes they are, but not always; for the babies of certain kinds of sea firs behave in a most surprising way. When the nursery doors open, instead of little planulas an excited troop of wee jellyfishes come bustling out and start dancing and frisking about as if they were full of joy at finding themselves at liberty in the free and open sea.

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These "surprise babies" are exactly like the big jellyfishes that swim lazily about in the ocean in the summer and autumn days. But of course they are very much smaller—so small, in fact, that they can be seen distinctly only when they are caught and placed in a watch crystal full of sea water under the eye of the microscope. Yet to all intents and purposes, these tiny things are jellyfishes, just wee, transparent, gayly tinted umbrellas with a fringe of glittering rainbow-colored

Some have a circle of vivid points of light bordering their dainty bells; others have one central lamp illuminating the entire animal. There is nothing more thrilling than to row or sail on a summer night out into a quiet bay and watch the dark waters sparkle and flash as millions of these living lights dart swiftly hither and thither like shooting stars. Sometimes the water is so bright with the multitudes of these phosphorescent jellies that we seem to be afloat on a sea of liquid



Painted Especially for This Work

It is not the moon that gives these waves their pearly light. Millions of little sea creatures illuminate the

water with their own gleaming bodies till it shines like molten silver—a sea of cold fire.

tentacles all around the edge. Underneath, where the stick of the umbrella should be, is a tiny mouth.

### When the Sea Glows at Night

The hydroid jellies are the loveliest of tiny creatures. They have been compared to floating flower buds and fairy bells. What they lack in size they make up in numbers; the surface of the sea is sometimes tinged for miles by multitudes of these tiny colored bodies moving about together in enormous shoals. On still, sunny, autumn days certain kinds of these wee jellies swarm in immense numbers off the coasts.

But if they are like flowers by day, at night the jellyfishes gleam like jewels, lighting up the sea with fire—called luminescence (lū'mī-nēs'ēns)—as they glow and sparkle in the surface waters of the ocean.

fire. There is no fear, however, that we shall be burned up, for there is no heat in the phosphorescent light given out by these tiny creatures.

Now one would imagine that after they had roamed about in the sea for a bit these little jellyfishes would follow the example set by so many of their relatives. We should expect them to settle down sedately on some comfortable spot, change their shape and their ways, and become the founders of new hydroid colonies. But no, nothing of the sort! These restless jellies never settle down. "Once a jelly, always a jelly," seems to be their motto; and jellies they continue to be throughout the whole of their little lives. So they spend the warm summer and early autumn days merrily swimming about by opening and shutting their tiny umbrellas in the blue water. With their ever restless

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Photo by American Museum of Natural History

All this is under the sea! The old wooden posts are covered, not with vines, but with various sorts of little sea animals, such as the hydroids that look like tufts

of the flowers we call Queen Anne's lace. Two inquisitive little fish are seeing what they can find, and a beautiful jellyfish—at the right—is floating lazily by.

tentacles they clutch everything eatable that comes their way. Of course they are often eaten up themselves, for although such tiny jellyfishes can hardly be very satisfying to hungry animals, they are swallowed in thousands by fishes and other sea rovers. But the gay, careless life of these strange little

creatures is not altogether a fruitless one. Although they do not found colonies, toward the end of the season some of the wee jellies who have not come to an untimely end produce a quantity of very small eggs, which are carried about in special nursery pockets underneath their umbrellas.



Photo by N. Y. Zoological Society

In various tropical seas where the bright-colored corals grow, live these strange fish called groupers. A few unlucky ones live in various large city aquariums, too, and there one may see them going through their paces. In only a moment they change from yellow to red, and then to a rich chocolate brown—and then, while

you stare, they change themselves back again! They can put on stripes or spots whenever they take the notion, and can shift them about under your very eyes. This change makes a grouper hard to see against a colored ocean floor. The tiny bright-colored Hydroids have thus influenced much larger forms of life.

When the eggs are ready to hatch, the little mother-jelly loses her energy. Her tiny umbrella turns inside out; and as soon as her children make their escape into the water, she shrinks up and is dissolved away by the action of the sea.

### A Jellyfish's Queer Offspring

But what of the children? Are they wee jellyfishes too? Oh, no! They are not in the least like their parents. They are planulas—just oblong, transparent specks of things covered with swimming fringes, as their grandparents were. After they have drifted about for a while they sink quietly down to the bottom of the sea and grow into sea firs!

The curious life history of the hydrozoa is called an "alternation of generations," and

is one of the strangest of many strange stories of the queer little people living in the sea.

First, from the hydroid colony tiny, free-swimming jellies appear. These are the children of the sea fir. Then from the eggs of these jellyfishes come little planulas, grandchildren of the sea fir. These planulas, in their turn, grow into sea firs again; and so the story goes on!

### A Craft That Never Comes to Port

Some families of hydroid polyps prefer a roving "life on the ocean wave" to staying at home, always fixed to the same spot. So instead of growing into sea firs they combine to form a wonderful little sailing vessel called a "Portuguese man-of-war," in which they set forth on a voyage of adventure.

The little ocean craft is really a wonderful

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affair. It consists of a large gas-filled bladder, rather like an airship in shape, that floats on the water. On the top of this float, a low crested ridge acts as a sail to waft the fairylike craft along, while a tangle of polyps and long, wriggling tentacles trail in the water below.

The long tentacles are armed with formidable batteries of sting cells. It is their duty to seize and sting into helplessness tiny fishes and any other small sea creatures they can catch as the boat sails along. Then the polyps—which are just so many hungry mouths—fasten on the victims and soon make an end of the poor things. A fleet of these “men-of-war” sailing before the wind out in mid-ocean, their delicate floats gleaming like molten silver shot with soft hues of violet, purple, and blue, is one of the most charming sights you can imagine.

Another of these wandering hydroid colonies goes by the name of “by-the-wind sailor.” It is only one or two inches long and is like a fairy raft with a delicate, transparent sail tinged with rainbow hues. All around the edge of the dainty craft a fringe of bright

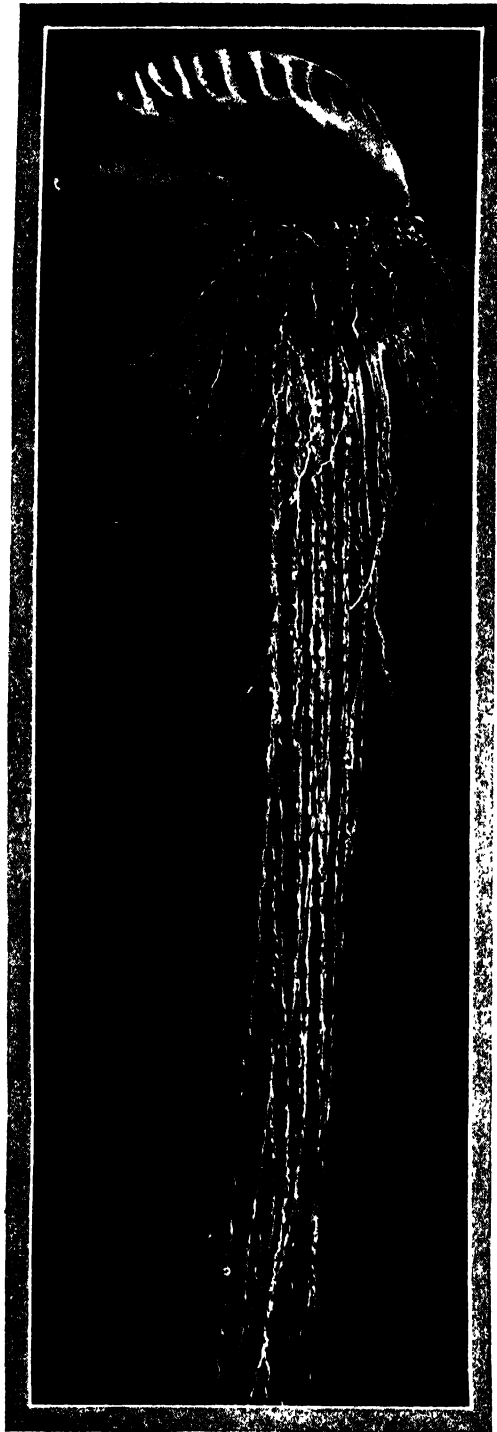


Photo by American Museum of Natural History

This handsome craft is the Portuguese man-of-war that sails the summer seas. Under the pretty umbrella is a colony of hydroid polyps that see the world in this way.

blue tentacles lashes the water and so helps to speed the little “sailor” on its way.

The big cousins of the little hydroid jellyfishes are quite as interesting in their way as their smaller relatives—though when we see the great jellyfishes stranded on the shore, looking like nothing so much as uninviting lumps of blanc mange or jelly which has not properly set, they certainly do not appear to be either interesting or beautiful. It is difficult to move these wobbly things without breaking them; but if we can manage to turn one over we shall find that in the center of the lumpy mass is a round opening into which we can easily push a stick or pencil. This is the mouth of the creature. It was hidden from view, when the jellyfish was swimming in the sea, by long, fluttering ribbons called the “mouth arms.”

A helpless jellyfish slowly dissolving away in the sun on the seashore does not appear to best advantage. When alive and active in the water it is altogether a different creature. With ribbons flying and fringes fluttering, it sails slowly and majestically along, opening and shutting its umbrella with



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steady, rhythmic movements as regular as the "tick, tock, tick, tock" of a grandfather's clock.

If we row out on a still summer day into the deep, quiet waters off the coast and look down over the side of our boat, we may chance to see a shoal of great jellyfishes rise up from the mysterious depths of the ocean and pass before our eyes in an endless procession of dim, ghostly shapes. They move away into the distance or sink slowly out of sight. We need to watch very intently, as jellyfishes are not easily detected in the moving waters. They do not "jump to the eye," as our French friends say. Their semi-transparent bodies—milky blue or a pale shade of green, brown, or purple—and their slow, graceful movements blend perfectly with the color and motion of the summer sea. Moreover; during the bright hours of the day the jellyfish, like most sea creatures, sink deeper in the sea, rising again to the surface after the sun has gone down.

The true jellyfishes vary in size from little things hardly an inch in diameter to monsters measuring four or even six feet across. Some have wide, spreading umbrellas; others are bell-shaped, with the "mouth arms" hanging down in the middle like a bell clapper. But all jellyfishes, great or small, are bordered with a fringe of tentacles armed with batteries of stinging cells; and some of the larger kinds will sting you smartly if you brush against them while bathing. They are, however, not nearly so dangerous to human folk as is generally believed; and the pain caused by their stings will pass off, as a rule, in an hour or two.

To small, tender-skinned sea rovers the

sting of a large jellyfish is quite a different story. A shrimp, a prawn, or a young fish is lost if it so much as touches one of the deadly tentacles. It is rendered helpless by the poisonous darts which pierce its delicate body, and is then pushed whole into the mouth of its captor. Some jellyfishes actually seize and swallow fishes larger than themselves, though of course such a big prize is not dispatched so quickly as the smaller fry. The big fish will struggle to tear itself free from the terrible tentacles; but it is no use.

The fish has no chance against the broadsides poured forth by its enemy. Yet, strange to say, some of the big jellies allow their umbrellas to be used as a kind of traveling tent by certain tribes of little fishes. Shoals of young whiting are sometimes seen in the North Sea playing around a big blue jelly, whisking their little tails and darting after every scrap of food floating by. Then something suddenly alarms them and they all dash for shelter "under the old umbrella," and the jellyfish actually puts up with their impertinence

and makes no attempt to capture them! Baby horse mackerel, young haddock, and cod take the same liberty with other big jellies on both sides of the Atlantic; and in American waters tiny butterfish behave in the same impudent way. The conduct of the little butterfishes is even more brazen, for they have been seen to bite pieces off the fringe of the umbrella that shelters them. The big jelly retaliates occasionally by catching one of its unmannerly little guests and making a meal of him.

Many jellyfishes are wonderfully brilliant at night. Some of the bigger ones glow in the dark waters like globes of white fire.

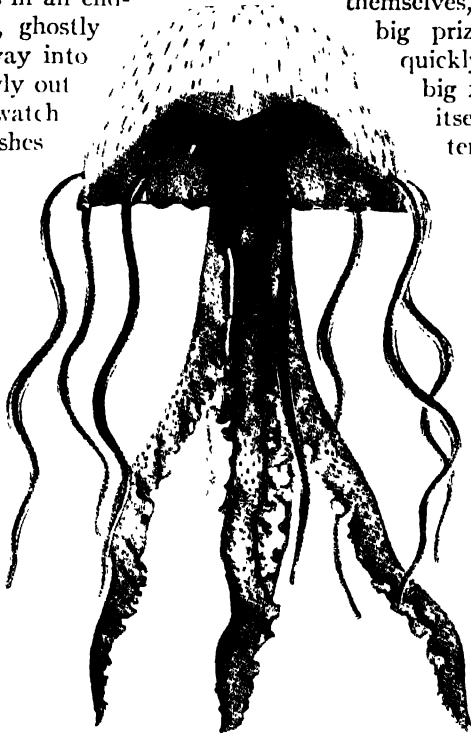


Photo by American Museum of Natural History

There are different kinds of jellyfish, and here is a model of one of them. Notice the big umbrella which it opens and shuts to send itself along.

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Others shine with a pale blue or greenish light that comes and goes as they drift lazily along, trailing their long streamers behind them in the quiet summer sea.

Sometimes the entire jelly is luminescent, but in some species the mysterious light is confined to the tentacles and the border of the bell or umbrella. They surround the floating jellyfish with a ring of pale, ghostly light or, in some cases, with a wonderful golden radiance.

One beautiful little luminescent jelly is quite a common visitor on the New England coasts. In the daytime he looks like a tiny glass bubble, but at night he gleams with a deep blue light. Such vast numbers of these little creatures sometimes swarm near the shore on a calm warm night that they give a bright, metallic glitter to the waves.

Jellyfishes are very delicate and cannot bear being buffeted about. Toward the end of the year, when autumn gales rage in the Atlantic, the frail things are tossed about by the waves and swept in millions toward the coast, to be flung up on the shore or dashed and ground to pieces upon the rocks. This rough treatment so excites the jellies that they light up all their lamps and shine with their utmost brilliance. Every wave, as it breaks on the rocks, is followed by a blaze of light, while the spray tossed skyward falls back in a shower of golden rain.

One of the most wonderful displays of these "living fireworks" is to be seen at Spouting Horn, on the New England coast. There the water, filled with gleaming frag-

ments of jellyfishes, is forced with a deafening roar through a small chimney in the rocks; a glittering column, like an illuminated fountain, rises high into the air.

The end of the summer means the end of all things to most of the jellyfishes. Few, if any, survive the winter gales, except in tropical regions, where young jellies

are able to live and grow undisturbed in warm, peaceful waters. Yet, although nearly all the jellyfishes may perish in the autumn, there will be just as many floating serenely in the summer sea the following year. For while the winter storms are raging, the children of these jellyfishes are safe in harbor, firmly anchored in the quiet, shallow waters.

These children, like the children of the hydroid jellies, are called planulas. After escaping from the eggs broadcast into the sea by Mother Jellyfish, they spend a short time swimming about in the water, as most sea babies do. Then each tiny creature seeks a home for itself in some sheltered spot, where it may live and grow in peace until the coming of the spring.

The young jelly is at first a tiny, transparent, pear-shaped thing fixed by its stalk—or rather by the end

where the stalk should be—to its chosen base. In a little while a wee mouth with a circle of tentacles appears at the free end of the creature. It is then almost exactly like its cousins, the polyps of the sea fir colony. It grows and lengthens, gradually altering in shape until it looks like a pile of saucers, with scalloped edges, placed one on top of another. By the time the little column is nearly an inch in height the worst of the

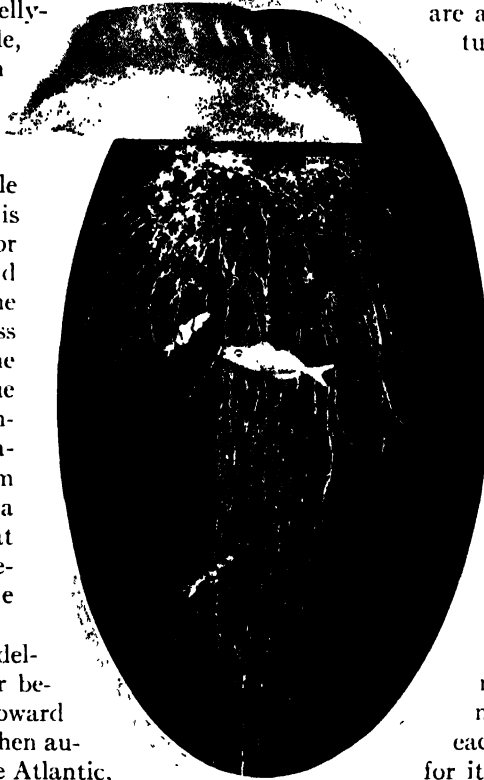


Photo by American Museum of Natural History

**These daring little fish have somehow persuaded the Portuguese man-of-war to let them live under his umbrella. Why he does not seize them in those long tentacles, no one seems to know; any other fish except his little boarders would instantly be gobbled up.**

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## THE STORY OF THE SEA

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winter has past. Then one by one the saucers break away from the pile, turn upside down, and swim off as tiny jellyfish. They now grow fairly rapidly, develop tentacles and streamers, and, if they are not gobbled up by other sea creatures, become in due course the large, handsome jellies that sail the summer seas.

### Gooseberries That Grow in the Sea

There are a great many different kinds of sea jellies and although, of course, there is a marked family resemblance among them they are by no means all exactly alike. They vary in size, in shape, and in color, and to some extent, too, they vary in their behavior. For example, some little planulas instead of turning into a pile of saucers throw out a number of threads in all directions, like strawberry runners. All along these threads little budlike things spring up at intervals, like young strawberry plants. Then some, or perhaps all, of these buds grow into piles of young jellyfishes. So in the end, hundreds of big jellies may all have come from one tiny planula!

Before we leave these fascinating lamps and stars of the sea and introduce ourselves to some of the other interesting inhabitants of old Father Neptune's kingdom, we must meet some of the little "comb jellies," or "glass gooseberries," as they are often called. They are too important to be passed by without having any notice taken of them.

Comb jellies live in immense numbers almost everywhere in the surface waters of the ocean. In warm, tropical seas and in the cold waters of the Arctic and Antarctic oceans these quaint creatures are al-

most sure to be found at certain times of the year. They are, with a few exceptions, tiny things, not much bigger than hazelnuts, and look like wee melons, pears, apples, gooseberries, pixy caps, or thimbles, all made from the clearest rainbow-tinted glass. Instead of carrying fringed umbrellas these lovely little crystal globes are divided lengthwise by eight bands covered with cross bands, or combs, of finest hairs. These combs act as paddles. As the little jellies paddle themselves about, the constant rippling movement of the fine hairs causes lovely rainbow colors to play over the transparent bodies of the little creatures.

A "glass gooseberry" has no sting cells like other jellies. It is provided, instead, with two long, fine, feathery streamers covered with tiny blobs of sticky stuff that holds fast the wee floating sea folk who chance to brush against it. The gooseberry whirls and twirls about in the water, trailing its sticky fishing tackle behind it; but if it is startled, the funny little thing hastily draws in its streamers and packs them away in two handy little side pockets.

### Pink Thimbles for the Mermaids

One beautiful comb jelly, named Beroë (bēr'ō-ē), differs from all the others in having streamers. It is larger, too, than the glass gooseberries and not quite so transparent. Beroë is found floating near the surface of the sea in most parts of the world; it may be known by its shape, which is like a thimble, and by its pale pink color.

But the most remarkable of all the comb jellies is "Venus' girdle," of the Mediterranean Sea and the Atlantic Ocean.

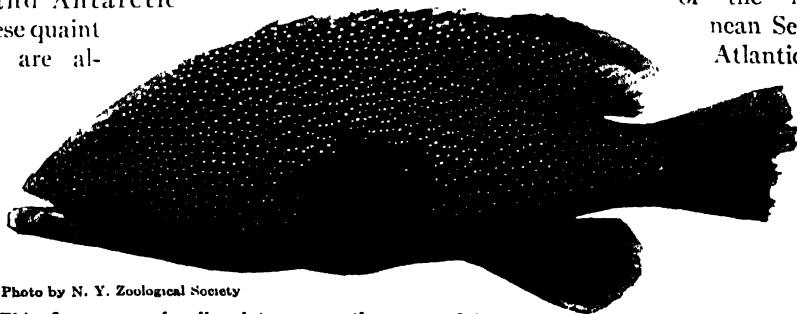
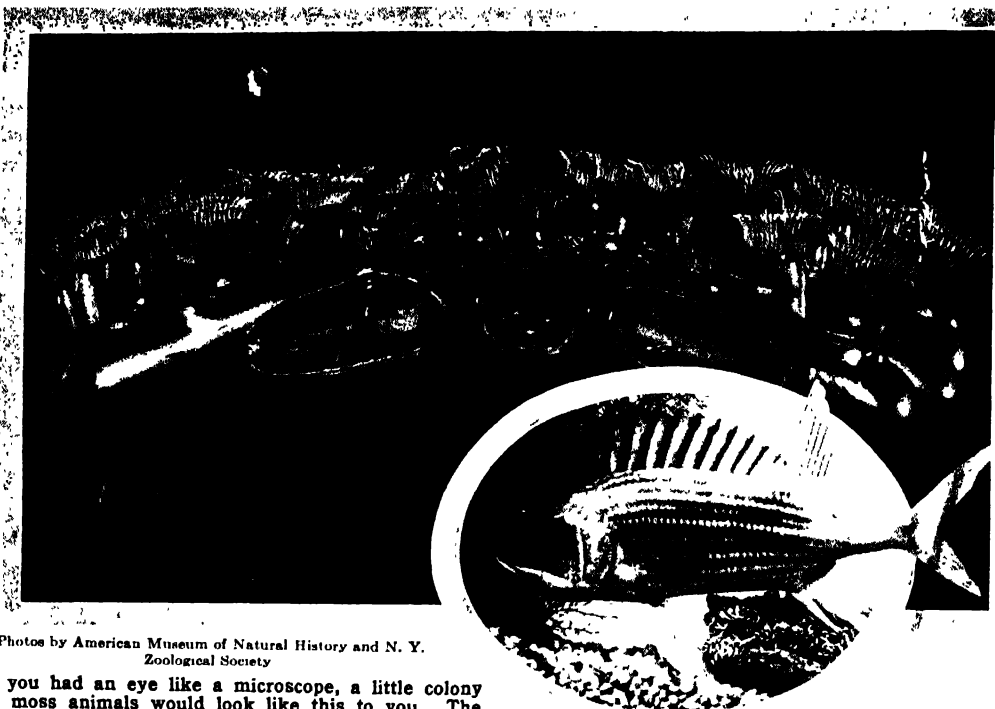


Photo by N. Y. Zoological Society

This fine array of polka dots covers the coney fish, which lives along the southeastern coast of the United States and around the West Indies. He is hard to see against a background of Hydroids or coral.

## THE STORY OF THE SEA



Photos by American Museum of Natural History and N. Y. Zoological Society

If you had an eye like a microscope, a little colony of moss animals would look like this to you. The squirrel fish down in the corner finds them a charming sight, for he has discovered that they make an excellent meal.

It is one of the most beautiful sights of the sea, moving in the daytime with graceful, coursing movements like a long silvery ribbon gleaming with violet lights. At night it shines with a brilliant orange luminescence. These jellies are sometimes two or three feet in length, and are so delicate that it is almost impossible to remove them from the sea without breaking them.

### Animals That Look like Moss

When looking for sea firs and other treasures among the tangled heaps of seaweed turned up on the shore, we are almost sure to find one or two bunches of leaflike things that have a faint, curious smell rather like the scent of geranium leaves. The leaves are flat and stiff; one might almost imagine that they had been cut out of pale brown paper and pricked all over with a pin by someone who had nothing better to do. But do not throw these papery bunches carelessly aside as things of no consequence, for like so many other strange things that come out of the sea, they are much more

interesting than they appear to be at first sight.

Now, as you may have guessed, these dull-looking bunches, which are called "sea mats" or "sea wrack," are not weeds at all. Like the sea firs, they are animal colonies, and were once inhabited by a huge and thriving population of odd little creatures called "moss animals," or Bryozoa (bri'ô-zô'â). If we look at one of the leaves through a magnifying glass we see that the pin pricks are not really round, but are almost the shape of round-toed shoes, all arranged in neat rows with the toe of one shoe overlapping the heel of the one just above it.

### Snug Homes for Curious Water Folk

Each of the round-toed shoes represents the home of a little moss animal. At the top are four small, transparent horns—two on each side—and in the center, near the top, is another semicircular mark, a round hole, or what appears to be a tiny pair of lips. These are the windows of the house, either tightly closed, wide open, or open just a little way, as the case may be. Through

## THE STORY OF THE SEA

these windows the tiny owners of the houses pop their heads when they wish to know what is going on in the world outside.

Moss animals are in no way related to the hydroid polyps. They belong to a higher race of sea creatures and are not so dependent on their neighbors as the simple little hydroids are. But the cells in which the moss animals live are all connected by a soft, sensitive lining; when danger threatens any of the community the news is probably sent by wireless along this lining to the rest.

### How Moss Animals Got Their Name

On every square inch there are hundreds of busy little neighbors living side by side. When all their feathery heads are stretched as far as they will go out of the windows of their houses, the sea mat looks just as if it were covered with the softest, finest moss. This is why these tiny sea folk are called "moss animals."

Each moss animal has no less than thirty long, fine tentacles arranged in a circle round its mouth, forming a kind of funnel. There are no sting cells on the tentacles, but down each side is a fringe of fine hairs, like the bands of cilia on the comb jellies. The constant lashing of these hairs sets up little whirlpools in the water. All sorts of tiny things, as they float by, are caught in the whirlpools, sucked down the feathery funnels, and swallowed by the hungry, open mouths of the moss animals.

### Do Sea Folk Have Policemen?

They are highly nervous and extremely cautious little beings. However intent they may be on catching their dinner, a shadow passing overhead, or a flick from the tail of a small fish swimming past in a hurry, sends all the moss animals indoors in a panic of alarm. Every feathery head disappears in a twinkling and all the little windows are shut up with a bang.

Some of these odd little creatures have actually a kind of police force attached to their colonies, whose duty it is to warn off all unwelcome intruders when the inhabitants are busy fishing, and keep the city clean and in good order. These particular moss animals are called "bird's head" Bryozoa. Their homes are built up in the shape of a bushy little tree, some two or three inches high. Guarding each cell is a queer-looking object like a vulture's head on the end of a long, snaky neck. These birds' heads twist and turn about, snapping their beaks angrily at everything that passes. They pick off any bit of rubbish that falls on the city and fling it indignantly away or seize and shake any tiny animal that ventures too near. Sometimes several birds' heads will all clutch the poor thing at once, pulling and tugging at it until it is torn to pieces!

Other colonies replace these "policemen" with a number of long whips, or "lashers," that beat the water furiously to keep tire-some visitors at bay.

### When Crabs Collect Moss

There are a great many kinds of these strange moss animals. Most of them live in deep water, though a few specimens may sometimes be found in the low rock pools. Some grow in bushy tufts or graceful sprays on the rocks or on coral reefs; others spread a lacy network of cells over old shells or the fronds of seaweed; others, again, grow up into sea mats; and some even fix themselves to the backs of crabs—who ought to be glad enough of this strange camouflage.

Almost everywhere under the sea some of these little moss animals are to be found, from the warm tropical waters to the cold seas of the polar regions. Those living far out in deep water often form large colonies, reminding us of masses of coral, although they are in no way related to the little coral polyps.



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# ***The STORY of LIFE in the SEA***

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## **Reading Unit No. 6**

### **THE STRANGEST WORMS OF ALL**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

The struggle for existence in the ocean, 3-117-118

Spirorbis, the worm with a trap-door, 3-118

Tube worms, 3-119-23

Worms that build the tubes you see on oyster shells, 3-121-22

Wandering worms, 3 123-24

Worms that shine like fireflies, 3-124

Worms as long as sea serpents, 3-124-25

The bristly "sea mouse," 3 125-26

#### ***Things to Think About***

How does a sea worm get material for making its hollow tube?

What makes the hollow tubes or "chimneys" we find on old sea shells, rocks, and wharf piles?

How do sea worms build their

homes?

What unusual ability is shown by a ribbon worm that has been cut in two?

How did the "sea mouse" get its name?

#### ***Picture Hunt***

Why do sea worms wave their tentacles? 3-117

To what use do sabella worms put their tentacles? 3-118

How do bristles help a worm to make a burrow? 3-119

Why is it an advantage for a worm to plug up its tube? 3-120

Of what use to a worm is a tube that projects a bit above the sandy sea bottom? 3-121-22

What remarkable trick often saves a scale worm's life? 3-124

How many legs has the "sea mouse"? 3-126

#### ***Leisure-time Activities***

**PROJECT NO. 1:** Visit the sea-shore at low tide and dig for worms. Study them by breaking

one side of the tubes. Inspect old sea shells for tube worms, 3-118-22.

#### ***Summary Statement***

The fierce struggle that living things face in order to live goes on in the sea at all times. Worms are no exception. To survive,

they have built hard, stony tubes in which to hide. Some are able to grow new heads or tails if they are cut in two.

## THE STORY OF THE SEA



Photos by American Museum of Natural History

These are magnificent crests for a mere worm to wear. All the creatures have drawn themselves part way into their tubes, and the one on the right has folded his plumes neatly and is probably sound asleep. But wait

till these serpulids get hungry! They will stand up in their chimneys and lash the water with their crown of tentacles. All over the rocks around them are delicate little moss animals, or Bryozoa.

### *The STRANGEST WORMS of ALL*

*If You Are Thinking of Being an Architect, Just Study the Homes of the Worms That Live in the Sea*

**T**HE sea people do not always enjoy a perfectly peaceful, carefree life in the wonderful salt-water kingdom. Danger lurks on every side. Unless you are very big and strong or wonderfully quick and sly, you do not flaunt about too openly in the great water highways, attracting the attention of hungry sea rovers ready to snap you up without a moment's hesitation.

Many of the larger creatures are armed with terrible teeth, strong, cutting claws, or sharp spines with which to defend themselves or to attack their foes. The lesser, weaker folk, who are unable to fight, resort to all sorts of cunning devices to enable them

to hold their own in the struggle for life that is always going on under the sea. The soft sponges have thin, prickly spicules (spīk'ūl) and an unpleasant smell, which makes other creatures give them a wide berth. The anemones, corals, and hydroids rely on their batteries of stinging threads both to capture their food and warn off their enemies. The coral people and the hydroid polyps, moreover, have strong, stony fortresses or prickly sea fir colonies into which they can retreat when danger threatens. The moss animals retire into their houses and shut their windows up tightly against intruders, or scare them

## THE STORY OF THE SEA

away with their lashers and funny, snapping birds' head police guards. Other sea creatures disguise themselves, dressing up in all sorts of odd ways the better to deceive their natural enemies. A great many small folk simply hide in the sand and mud or tuck themselves out of sight in holes or rocky crevices. The more industrious among them build tubes and towers and chimneys where they may live in peace and escape the eye of those who seek to devour them.

Among the more feeble sea folk are a number of small marine worms. You would gasp with astonishment if you could see the vast hosts of these wriggling creatures, of all sorts and sizes, that lie buried in the mud and sand in the shallow water round the coasts and still further out to sea. They are a strange collection of animals, not, as a rule, at all like the common, or garden, earthworms. Some, to be sure, are horribly ugly; but others are really lovely things, which it is difficult to believe are only humble worms.

Not all sea worms are feeble folk. Some are horrible monsters, terrors to all little sea dwellers, including their own small relatives. These worms wander about, boldly seeking whom they may devour. But the majority are shy and retiring in disposition, lying in burrows under stones or in neat little homes which they build for themselves.

There are so many tribes and families of these humble creatures living in the sea that they are really quite bewildering. We may class them roughly as "smooth" worms, which have long, smooth bodies made up of

a number of rings or joints, and "bristle" worms, which are distinguished by having spines and bristles, or tufts of stiff hairs, projecting from their sides. These two classes may again be divided into "wandering" worms and "stay-at-home" worms.

One of the neatest, daintiest little houses is built by a worm of fairylike size and ap-

pearance named "spirorbis" (spī-rōr'bis). Fronds of seaweed are often seen dotted all over with tiny white shell-like things no bigger than a pin's head. If we look at them through a magnifying glass, we see that they are really delicate tubes, twisted round like a coiled-up rope. These are the homes of spirorbis worms, made by their owners from the carbonate of lime they extract from their food. There they live secure, carefully shutting themselves in with a little trapdoor, which fits the opening of the tube like a lid. The spirorbis never leaves its home altogether. When in need of food or of a fresh supply of oxygen, the trapdoor opens and a tiny head, crowned with a circlet of fin-



Photo by American Museum of Natural History

Here is a member of the family of the handsome sabella worms. His head is gorgeous with a pair of feathery fans that are of great use to him in digging. It is not hard to see why certain members of the family should be called peacock worms.

est, feathery plumes, cautiously appears and begins to sway about in the water. The feathery plumes are the gills of the little worm, by means of which it breathes. Their movements produce currents in the water, by which minute particles of food are swept into its mouth.

The trapdoor with which the spirorbis shuts itself indoors is contrived out of one of the animal's feelers. Instead of being feathery, it widens out at the tip like a spoon, forming a perfect stopper to the open end of the tube.



## THE STORY OF THE SEA



Photo by American Museum of Natural History

Dig just a little way below the bottom of any shallow pool along the seashore, and this is the squirming mass you will find. But look at them carefully and

see the fine bristles all along their sides. They spend their lives burrowing about in the roots of the eel grass growing above them.

Worms are not at all sociable in their ways. They roam about all by themselves if they are wandering worms, or live alone in solitary state in their own private houses if they belong to the home-keeping varieties. Many tube-building worms, to be sure, build their houses side by side, so close together that they look like chimney stacks crowned with as many chimney pots, from which the feathery heads of the worms pop up like gayly colored chimney sweep's brooms. But this is more or less an accidental arrangement that occurs when a number of tube builders belonging to the same family happen to fix on the same spot for their building operations. Each chimney is erected quite independently by a separate worm. The neighbors are not connected one with another as the moss animals and hydroids are, although their tubes are often twisted and tangled up together when the little builders are so closely packed that they get in one another's way.

Wharf piles, old pieces of half-buried timber, rocks, stones, and old shells are all favorite building sites for these little home-makers. Compact masses of worm tubes formed by hundreds of busy workers are often left uncovered when the tide goes down. They look like sandy rocks upon the shore. Some worms bury their tubes. They leave two or three inches sticking up above ground in order to prevent their houses from being choked with soft sand and mud, or their feathery gills from being clogged when the heads are pushed up into the water to breathe and collect floating food. Some fix their tunnels on shells occupied by old hermit crabs, and so get carried about from place to place, enjoying frequent changes of air and scenery without any trouble to themselves. Others, called "quill worms," live in transparent tubes rather like the quill of a feather, and drag their houses with them wherever they go.

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One of the most interesting of the tube-building worms is the "fan sabella" (sá-bél'á), a really handsome fellow with a gorgeous headdress in the shape of two large fan-shaped, gayly colored gill tufts composed of no less than seventy or eighty feathery plumes. They may be of a pale straw color or pearly white, all banded and spotted with red, orange, green, yellow, and brown. When these fans are unfurled, swaying gently from side to side in the clear water, they look like strange but beautiful flower heads.

The fan sabella is a large worm living in a tube from twelve to fifteen inches long and about as big around as a lead pencil. The tube is made by its owner, with mud or fine sand grains all plastered smoothly in place, and is as soft and flexible as a length of indiarubber tubing. A number of these worms often live side by side half buried in the mud or sand on the seashore just above low-water mark. The tops of their houses may be seen when the tide is out, standing erect like a forest of little chimney pots. If these tubes are crowned by a drop of water just rising above the edge, we may know that the owners of the houses are within, ready to rise to the surface as soon as the refreshing waves ripple over them once more. But dry tubes are empty, and the once active little inhabitants dead.

There are several different kinds of sabella worms; all have fan-shaped headdresses, many of them, especially those in the tropic seas, rivaling gay butterflies in their brilliant and beautiful coloring. They are very industrious folk, always repairing and adding to their houses. Most of the work is carried on at night. But some of the little builders appear to labor almost incessantly, both night and day. Certain small members of the Sabella family seem to be unable to stop, and go on and on adding to the tubes until they are ever so much longer than the worms themselves.

Each worm has its own ideas on the subject of house building; one will use nothing but the softest mud, another chooses only the finest sand grains.

It is a most interesting sight to see one of these little tube builders at work. Round the base of its feathery plumes is a kind of velvety collar, divided into two little lappets. These the worm uses as trowels to beat and smooth the building material into position after it has been collected in the funnel formed by the feathery fans. The sabella twists and

turns its head about, sweeping the water to extract the liquid mud or floating particles of fine sand, while the little trowels work away vigorously pounding and molding the stuff into shape. All the tubes have a silky lining, soft and fine as spider's web. The worm climbs up and down

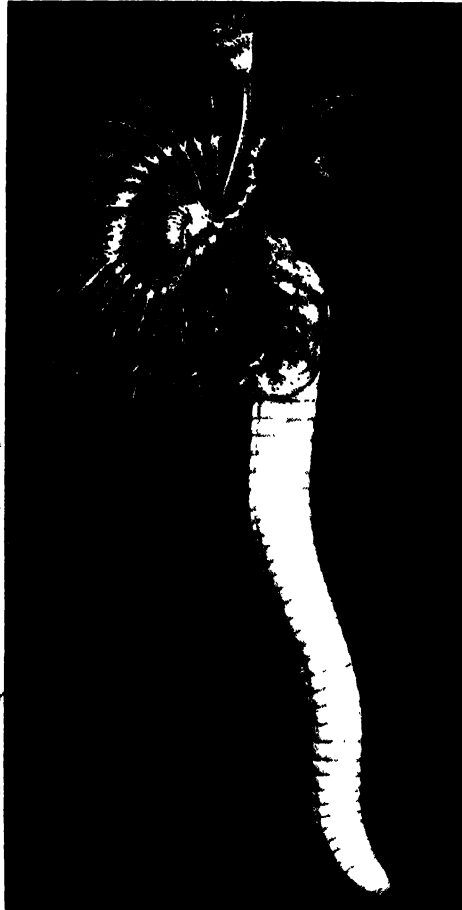


Photo by American Museum of Natural History

This capable sea worm lives in a tube and belongs to the same group as the serpulæ. His handsome crown of tentacles is covered with little eyes so sensitive to light that they tell him of even a shadow approaching. The long flower stalk on his head is really a neat little plug, with which he can cork up his tube whenever he goes indoors.

## THE STORY OF THE SEA



Photo by American Museum of Natural History

The two tall chimney stacks belong to plume worms, with one of them split down part way to show its owner at home. The shorter chimney stacks belong to trumpet worms; and at the left is a knot of writhing

bristle worms that do not bother to build themselves a tube. Above this sandy bottom are some two feet of water in a shallow seaside pool. And what a busy place it is when all its folk are hungry!

in its tube, and when its head is out of doors prevents itself from falling to the bottom of its house by clinging to the lining with its bristles, which are arranged in bunches all down its sides.

### A Worm That Builds with Lime

Those twisted, stony-looking tubes that we often see stuck fast by one side to old oyster shells, are the work of the serpula (sēr'pû-lâ) worms. They are made, like the coiled homes of the spirorbis, from the carbonate of lime extracted from the food swallowed by the clever little builders. On the seashore these worm tubes, all twisted and tangled into knots, abound on almost every old shell and boulder, and on the under side of rocky ledges. Nearly every shell, broken bottle, or piece of pottery dredged up from the depths of the sea has a clump of these

dirty-white, rough-looking pipes zigzagging over it.

These tubes are much longer than the worms who live inside them, and have trumpet-shaped openings which may be stopped up with things that look like scarlet corks whenever the owners of the crooked houses do not wish to be at home to visitors. The "cork" is a solid, cone-shaped stopper on the end of a long, flexible stem. It is really one of a pair of feelers, though the second feeler is so small that the serpula appears to have only one.

### Worms That Disappear like Magic

The feathery crowns of little serpulas are quite as brightly colored as those of the sabellas, and the "operculum" (ô-pûr'kû-lûm), as the stopper is called, is a most beautiful little thing. It is usually scarlet

## THE STORY OF THE SEA

or orange-colored, sometimes ringed with pure white.

These little tube builders must certainly have eyes in their heads, and very sharp ones too, for the slightest shadow in the water sends them indoors in double-quick

way across the creature's back. When the serpula wishes to retire in a hurry, it simply clutches the soft lining of its tube with these hooks, contracts its muscles, and is dragged down in a flash! There are no less than nineteen hundred of these hooks, and as



Photo by American Museum of Natural History

Over these few square feet of sandy bottom just under the water of a little low-tide pool are scattered the

time. At the first suspicion of danger the feathery heads disappear with a jerk and all the little trapdoors are clapped to in a lightning flash. So quickly does this happen that it almost takes your breath away and leaves you wondering how on earth the funny little creatures accomplish their wonderful "vanishing trick."

### Fourteen Thousand Grappling Hooks

Well, it is done in this way. The serpula's feet—which are like a row of pimples all down each side of its body—are fitted with rows of tiny curved grappling hooks, which extend along the top of each foot and half

chimney tops of the plume worms. One has been split open for you to see the plan of the creature's home.

each one is cut up into seven sharp teeth the serpula has in all about thirteen or fourteen thousand little grappling hooks with which to haul itself backward into the fastness of its tubular castle. But this is not all. The hindmost feet of the little worm—which is barely an inch and a half long—are different from the rest and are used as mops and scrapers to clean out the smaller end of the tube.

The Terebellas (těr-ě-bě'l'ă) are another distinguished family of tube-building worms. They work on quite a different plan from the sabellus or the serpulas. Their houses rise from the sand like tiny tree trunks,

## THE STORY OF THE SEA

with a circle of bent and twisted twigs arranged round the top. They are made with sand, tiny stones, and wee bits of broken shell. These worms have not the beautiful head fans of the other tube dwellers you have just noticed, but round the mouth and the bright scarlet gill tufts, about a hundred long threadlike feelers wave in the water when the terebella is on the lookout from the top of its tower.

Its feelers, or tentacles (tēn'tā-k'l), are the tools with which the little workman picks up its building materials from the sea floor. They are grooved throughout their entire length, and the grains of sand, the tiny stones, or the little pieces of shell slip along the groove to the worm's mouth. There they are moistened and coated with a kind of cement, and then placed in position on the edge of the tube.

One of these little creatures has been named the "sand mason" on account of the neat and workmanlike way in which he builds up his tower. Another—one that uses stone—is called the "stone mason" or the "potter"; and a terebella whose house is entirely made of broken shells is known as the "shell binder."

These tube builders always stay at home. Once they have built up their towers and chimneys, or long wriggling pipes, they never leave them. That is to say, they do not leave these shelters of their own accord; they are sometimes pulled out and devoured by greedy sea creatures, including some of their own wandering relatives. There are some small bristle worms, however, that like to have occasional outings. So when they wish for a little change they leave their tubes,

which are merely thin, jellylike cases, and go off for a swim, paddling along through the water tail first. Of course they cannot go back home again when they are tired of wandering about, but this does not bother the worms at all. They quickly form new cases, which are made simply of hardened mucus (mū'kūs), a slimy substance that comes from the worm's own body.

Then there are hosts of worms who do not worry to make houses of any description,

but are content to bury themselves in the soft, wet ground. Many of these hermits seldom leave their burrows. They live merely by swallowing the mud or sand for the sake of the small quantity of digestible matter it contains. Others hide by day and come out at night to hunt for food. Seaweed and even sponges are eaten by some of these worms; but most of them prey on shrimps, baby crabs, or small shell dwellers; and some of the unnatural creatures actually eat each other!

They are a strange company, these wandering worms of the sea. Many are bril-

liantly colored, the tint sometimes being due to the animal's red, pink, or green blood. Most of them possess feelers or tentacles of some kind and spines or bristles of varying lengths. The breathing gills of wandering worms are usually arranged in little tufts at intervals all down the sides of their long bodies.

### Fireflies of the Sea

Some have as many feet as a centipede, and can move over the ground and the rocks at an astonishing rate with a rhythmic, gliding motion. Others have feet like pad-



Photo by American Museum of Natural History

This strange worm lives in a siphon which he has built himself among the roots of the eel grass growing in a shallow seaside pool. Because the walls of his tube are very much like parchment he is called the parchment worm. He does not always live alone, for often tiny crabs come to share his dwelling with him.

## THE STORY OF THE SEA

dles; so they can swim easily and gracefully. Several sea worms are luminescent (lū'-mī-nēs'ēnt), gleaming in the darkness with blue, violet, and green lights as brightly as the fireflies that flit about the South American forests at night. Some will give genuine firework displays at times. If startled or annoyed they seem actually to blaze with excitement, and dart away through the water leaving a shower of fiery sparks in their wake.

Among the most determined hunters of the sea are the ribbon worms, or "boot-lace

When the tide is out a ribbon worm may often be found all twisted and tangled up into a knot under a flat stone low down on the seashore, hiding from any possible danger until the water flows in to cover it again. It is no use trying to unravel the creature, for although it is no thicker than a piece of stout string it may be several yards long. It is so very soft, too, that it is more than likely to break in two if we handle it, which would be embarrassing for us. The worm would not be unduly inconvenienced by the

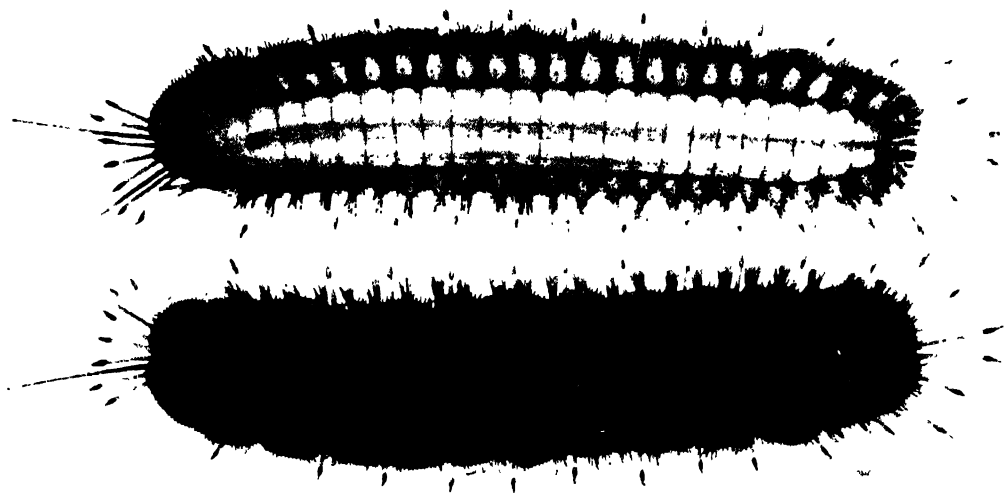


Photo by American Museum of Natural History

This clever suggestion for a fur neckpiece is a picture of the upper and under sides of the curious scale worm. He lives among seaweed and rock crevices along the shore, and is about two inches long, with a back that is protected by a double row of overlapping scales, and legs that are armed with bunches of golden

bristles. Spear-shaped tentacles and spines stick out from his head and between his legs. But besides this formidable armor he has an amazing trick to protect himself when pursued. For he casts off luminous scales that a hungry fish is sure to take after, while the wily worm makes his escape.

worms," as some of them are called. They have very long, smooth, ribbonlike bodies without any spines or bristles. Some of the family, for there are many of them, are to be found haunting the shallow coastal waters in most parts of the world.

Certain of these creatures are veritable sea serpents, thirty feet long or more; others hardly measure an inch. But they are all fierce and greedy, and will eat almost anything dead or alive that they can manage to swallow. They ruthlessly pursue and devour small sea folk of all sorts. The cannibals pull the little tube builders out of their homes and gobble them up, or make a meal of any of their own relatives that they are strong enough to overcome!

accident. Both halves would at once wriggle off as fast as they could go. The tail end might live and move about just as it was for a long time. The head end would proceed to grow a new tail, and all would soon be right again. One very large species behaves in an even more astonishing way. If, as frequently happens, it accidentally breaks itself into several pieces, each broken part grows a new head and a new tail and becomes a complete and separate worm!

As if their long, lanky bodies were not long enough already, these worms are able to stretch themselves out to a surprising degree. They have, too, a curious tongue, or proboscis (prō-bōs'is), that looks like a long thread, armed, as a rule, with a sharp,

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pointed spine. This proboscis can be shot out of the mouth a long way and makes a fine weapon for attacks or defense, or a useful tool with which to pull the poor little tube dwellers out of their chimneys. The worm can draw this proboscis back into its mouth as rapidly as it projects it, turning it inside out in the process, just as you might turn the finger of a glove inside out if you fastened a string inside the tip and gave it a sharp pull. Sometimes the proboscis is shot out with such a violent jerk that it breaks off; but the disaster is soon remedied, for the worm quickly grows a new one.

Most sea worms, and, indeed, many other sea creatures, are able to replace certain parts of their bodies if they have the misfortune to lose them; but few possess this wonderful power of "regeneration" (rê-jěn'ēr-ā'shŭn) to such a remarkable degree as the curious ribbon worms.

When the tide is out and the sun is down a strange little animal is often to be seen wandering about on the glistening sand close to the water's edge, or crawling briskly over the rocks and stretches of coral sand in one of those lovely "sea gardens." This is the "sea mouse," a quaint little creature only a few inches long, with a broad back covered with a soft, furry, mouse-colored coat. Unless you had received a hint, I do not believe you would ever guess that it is one of the great army of worms that live on the borders of the salt-water world, for it is the most unwormlike worm you can imagine.

Except for its furry coat it is not much

like a mouse, either. It is somewhat the shape of a long, flat egg coming to a blunt point at both ends, or rather, I should say, of half an egg cut in two lengthwise. Its back is rounded but its under side is flat. It would be difficult to tell which end was which if it were not for two little horns that stand out from the point of the animal's head. The back of the sea mouse is protected by a kind of armor of flat, horny scales; but you cannot see this, for it is quite hidden by the thick fur coat the creature wears on top of it.

So far, there is nothing particularly striking about the little animal. But standing out all around it is a marvelous rainbow fringe of the finest, softest hairs, gleaming with bright tints of green and yellow, blue, purple, and orange, like the breast of a humming bird or the gorgeous feathers in a peacock's tail. It is one of the most beautiful of all the sea worms.

The little sea mouse has another, more romantic name. It is called "Aphrodite" (ăf'rô-dî'tè) after the Greek goddess of beauty, who was said to have risen from the rainbow-tinted sea foam as it broke upon the sands. This high honor was bestowed upon the humble little sea worm on account of the pretty, many-colored halo with which it is surrounded.

Aphrodite, or the sea mouse, whichever you may choose to call it, is a timid little creature. It spends most of the daylight hours buried in the sand or hidden upside down under a stone, though

it is quite able to defend itself. Mixed with its long, fine hairs are a number of sharp-



Photo by F. Martin Duenen

Not a worm at all, one would say, but the spine of some fish or reptile. Yet this is the parchment worm—of course very much enlarged. It is a highly luminous creature, and gives off a vivid bluish-green or violet light.

## THE STORY OF THE SEA

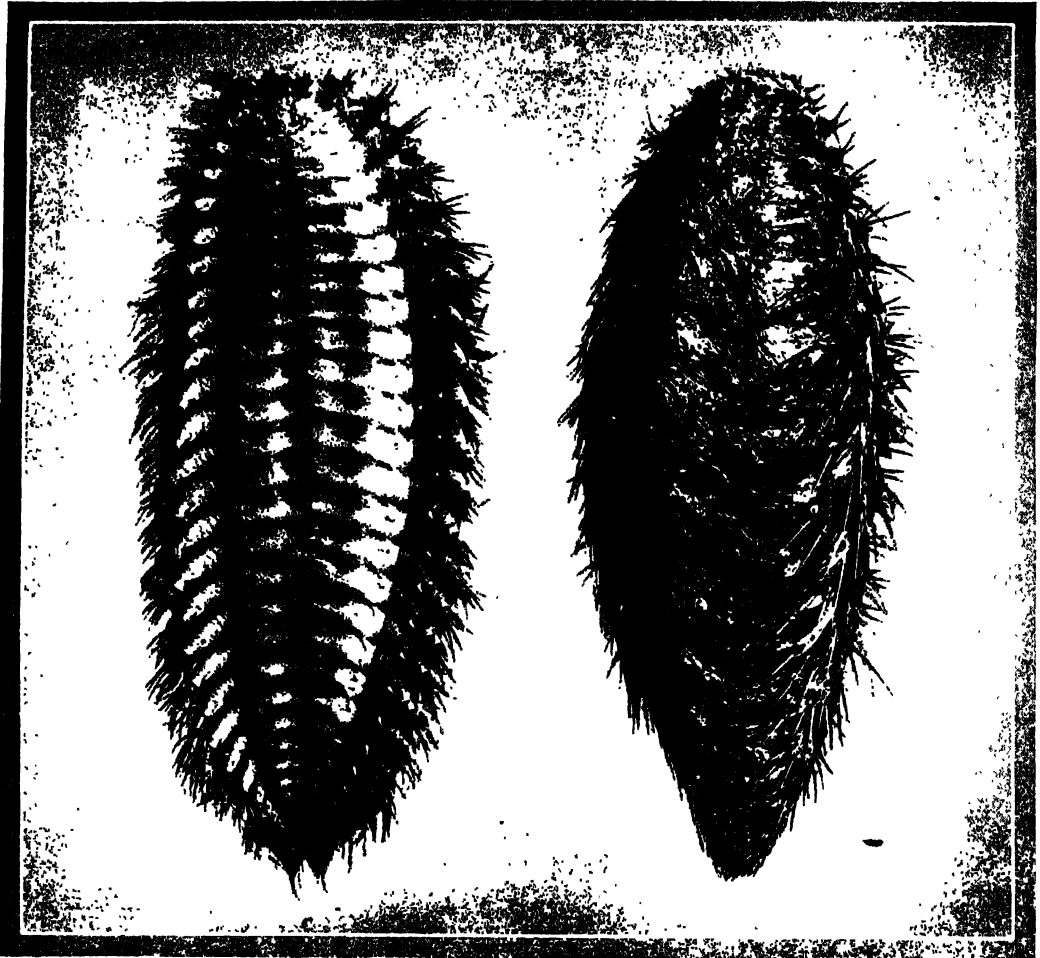


Photo by F. Martin Duncan

At the right is a life-size view of the hairy back of the strange little sea mouse. Under the feltlike covering are scales. The long rainbow-colored bristles all around the edge are what give the creature the poetical

name of Aphrodite. At the left is a view of its under side. You can see clearly all the twenty or more pairs of fleshy "false feet" on which the sea mouse can run so fast over the sand.

pointed bristles, which this peculiar worm, like a hedgehog, erects if it is alarmed.

It is very funny to see a sea mouse cautiously emerging from its retreat. First the sand in which it is hiding begins to heave and rise up in a little hump. The hump grows higher and higher. Suddenly it breaks and Aphrodite tumbles out, usually alighting on its back. It certainly does not look like a goddess of beauty now! It is just a small, wriggling bundle of wet sand. But the funny little thing soon rights itself, shakes itself free, and if the coast is clear starts off in search of its supper. So it putters about in

search of its prey; for the sea mouse eats all sorts of other little sea folk, including many of its smaller relatives. It can run very fast if it is frightened, which is not surprising, since it has no less than forty pairs of tiny feet beset with bunches of stout bristles. The latter are useful, too, for digging.

Besides its other accomplishments Aphrodite is an expert swimmer and sometimes ventures out into deep water. If it ventures too far, however, it runs the risk of never coming home again; for if it chances to meet with a codfish the pretty little thing will probably be gobbled up.



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# ***The STORY of LIFE in the SEA***

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## **Reading Unit No. 7**

### **FROM CUCUMBERS TO STARS**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

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How a starfish cleans itself, 3-130-31  
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A poor way to kill a starfish, 3-132  
Different kinds of starfish, 3-133-35  
The sea urchin, 3-135-38  
The sea cucumber, 3-138-39

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Why is water necessary to a live starfish?  
Why do oyster fishermen make war on starfish?  
How does a starfish overcome and devour an oyster?

What happens to a starfish that is torn apart and cast back into the sea?  
Why is it necessary for a starfish to lay millions of eggs?

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Why is protective coloration especially valuable to a sea animal? 3-134

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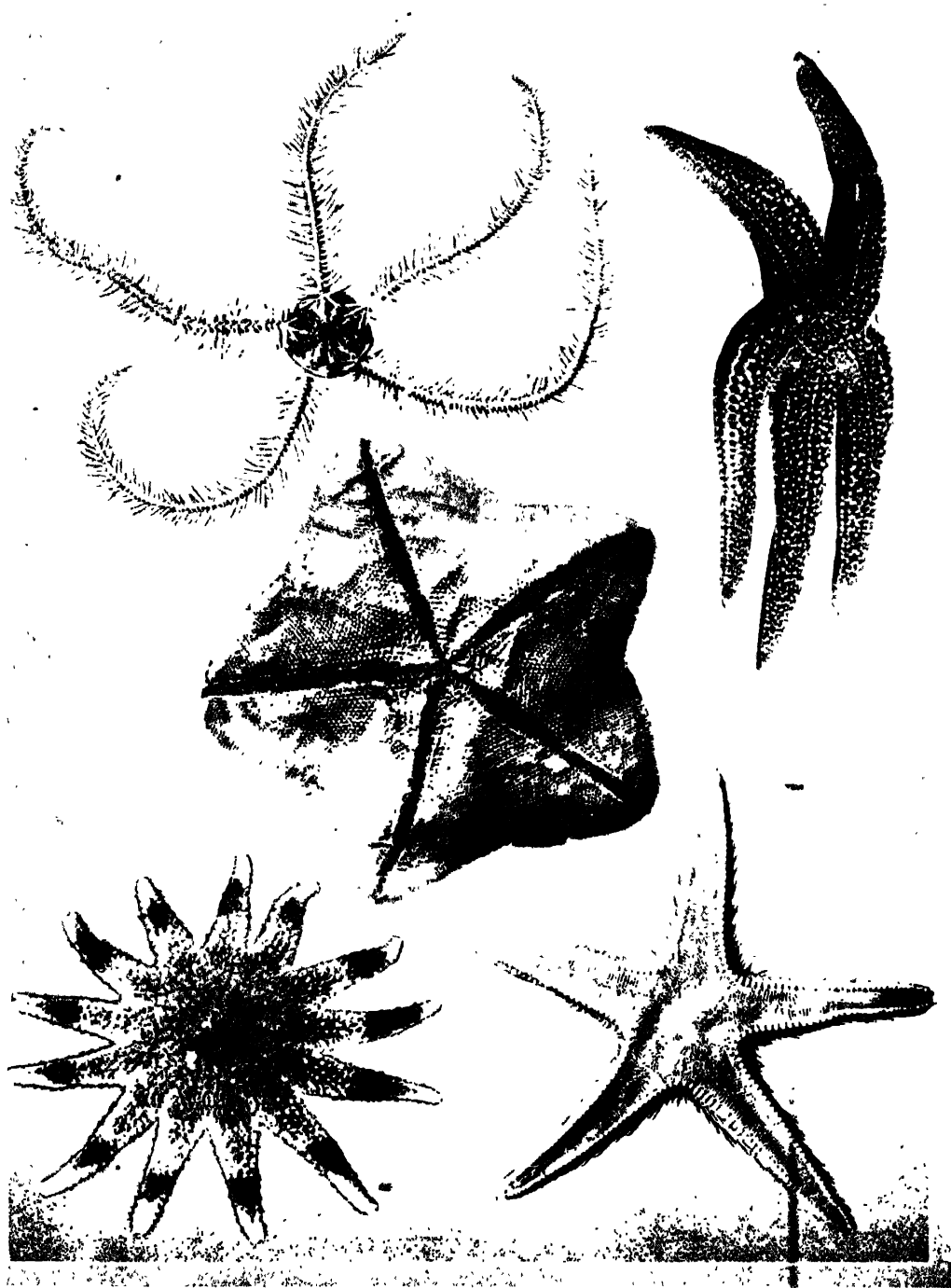
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PROJECT NO. 3: Examine a dead sea urchin and observe how it is adapted for life in the sea, 3-135-37

#### ***Summary Statement***

The starfish, sea urchins, and sea cucumbers are related to one another. They have tubular feet that help them move or get food. Most of them have prickles or spines on their skins. The star-

fish is able to push its stomach out of its body and there digest an oyster. The damage done by starfish to oysters makes the starfish a great problem to oyster fishermen.

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Photos by F. Martin Duncan

These plumes and pincushions are all starfish. In the upper left-hand corner is the brittle starfish, almost never caught with all arms complete. To the right is

the crossfish; in the center, the bird's-foot starfish—no thicker than a sheet of cardboard; in the lower left-hand corner, the sun star; to the right, the but-thorn.

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## THE STORY OF THE SEA

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When you've finished reading the story of life in the sea, you will be able to name every one of these strange creatures that swim and crawl and run and

burrow about in the dim light of the water world. Each one has developed his amazing traits to help him live in dangerous surroundings.

### *From CUCUMBERS to STARS*

*It May Seem a Long Way to Us Who Dwell on Land, but Down beneath the Sea the Two Lie Side by Side, Where They Are Close Neighbors to the "Urchins"*

**I**N THE deep, wide kingdom of the sea nearly half the creatures we meet are doing their best to look likesomething else. We soon grow accustomed to their tricks and disguises and are not deceived by the strange-looking things around us. They may appear to be flowers or trees, lumps of jelly, brightly colored stars, or plump cucumbers, but we know they are nothing of the sort. They are cunning sea people "making believe," the better to hide from their enemies or catch other little sea folk unawares.

Nothing could look less like a live, active animal than a starfish lying limp and helpless on the sand when, as often happens, it has ventured too near the shore and been left behind by the receding tide. It might be an orange-colored, star-shaped pincushion; there is no sign of a mouth, eyes, legs, or

claws. How in the world does such a creature breathe, eat, move, or defend itself?

Well, the starfish can do all these things very well, thank you! It is quite able to take care of itself. Far from being a poor, helpless lump of an animal at the mercy of everyone, it is so strong, greedy, and relentless that it is a terror to all sorts of little creatures living in the sea.

Let us take a good look at the starfish as it lies so innocently on the sea floor, and see what we can discover about this crafty individual. It feels rather hard and rough, for its skin is covered with little knobs and blunt prickles set closely together, making a kind of network all over its back, even down to the tips of its fingers—or rays, as they should be called. The little knobs are caused by rows of soft, hollow projections

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## THE STORY OF THE SEA

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under the skin; with these the starfish extracts oxygen from the sea water to enable it to breathe.

### Feet That Work by Water Power

Not quite in the center of the "star" but more to one side, near an angle formed by two of the rays, is a larger knob rather like a button or a tiny brainstone coral. This is called a "water tubercle" (tū'bēr-k'l). It is actually a filter through which a stream of water is constantly passing to fill a wonderful system of water pipes, or canals, which run throughout the body and all the way down the arms of the starfish. They keep it supplied with all the oxygen it needs and also help it to move, for the feet of this curious animal are actually worked by water power.

But where are its feet? Turn the starfish over and you will see. Down the middle of each of the five rays is a deep, wide groove, running from the center of the star right down to its finger tips. This is filled with what at first sight we might easily mistake for a lot of tiny, wriggling worms, all twisting, turning, and bending, stretching themselves out and sinking down again without a moment's pause. It makes you feel quite creepy only to look at them!

### How the Legless Starfish Walks

Of course these wriggling things are not worms; they are the starfish's feet, called "tube feet" because they are really little hollow tubes, as soft and flexible as if they were made of rubber. At the tip of each tube is a sucker. By stretching out its feet and grasping anything it can lay hold of with its suckers, the starfish can pull itself along at a rate that would surprise you.

Stranger still is the way in which the animal lengthens and shortens its curious tube feet. At the end of each one, just where it joins a water canal, is a kind of little bulb which is always kept filled. By the sudden contraction of this bulb, water is pumped

into the tube, which is pushed out much as the finger of a glove is inflated if you blow into it. Then, when the bulb is expanded again, the water is drawn back, and the tube foot shrinks accordingly. The bulb, you see, works much as does the bulb of a syringe.

Although by this peculiar method of walking the starfish can move over the ground fast enough when it wants to, it is by nature a dull, lazy thing. When it is not up to mischief it will keep quite still in the same position for days at a time.

The tube feet are very sensitive. If roughly touched they immediately shrink up. The two edges of the groove then begin to curl over so that the fringe of stiff spines that borders the rays is brought together, forming a kind of trelliswork covering

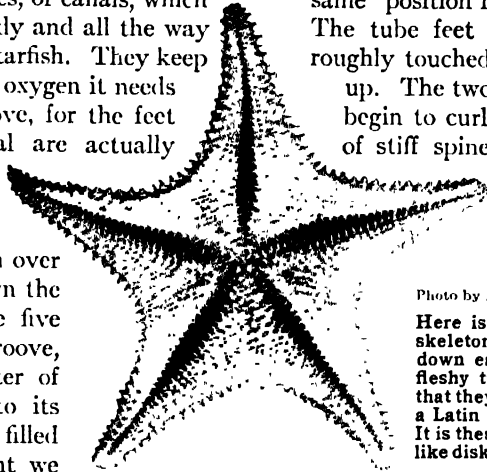


Photo by American Museum of Natural History

Here is the under side of a starfish's skeleton. In life the groove running down each arm has two long rows of fleshy tubes, ranged along so evenly that they are called the "ambulacrum," a Latin word meaning "garden walk." It is these tubes that end in the sucker-like disks with which the animal walks.

to protect them from injury. The last tube foot, at the end of the ray, is different from the rest. It is pointed and has no suckers; and just at the base is a tiny reddish cushion protected by a circle of small spines. This is the starfish's eye. There is one at the end of each ray; so we can say with truth that the odd animal "has eyes in the tips of its fingers." The eyes are not such wonderful organs as our own eyes are; I dare say the starfish cannot see very far or very clearly. But it can distinguish light and shade and the direction in which it wants to travel, and that is all it needs under the sea.

### How a Starfish Washes His Face

Now it is most important that the starfish should keep itself spotlessly clean, for if it were plastered over with sand and mud its tube feet would be clogged and its eyes would be useless. So to keep itself spick and span it has hundreds and hundreds of tiny pairs of pincers to pick off every speck of dirt



Photo by N. Y. Zoological Society

When you hold a starfish's stiff skeleton in your hand, it is hard to imagine that it was ever a part of a lithe,

graceful creature like the ones that are gliding so smoothly and easily over these rocks.

that falls upon it. These handy little implements are scattered all over the animal. Its back, each of its rays, and the whole of its under surface are crowded with them, but they are so small that we can see them only with a very strong magnifying glass. The two blades of these pincers have very sharp points and are mounted on long, flexible spines by way of handles. They are always on duty swaying this way and that, snapping up and flinging away every particle of sand or dirt or tiny scrap of seaweed that falls on the starfish. These pincers are useful, too, when anything attacks the starfish, for they nip the enemy and hold on like bulldogs.

### His Mouth Is in His Chest

But all this time that we have been describing him the starfish has been lying on his back, and he hates that. We will let the poor thing turn over and walk off, if he wants to, on his queer tube feet. But first just notice that little opening right in the middle of the gentleman's chest. That is

his mouth; and if you push a finger into it—which is quite safe, as a starfish has no teeth and so cannot bite—you will find that it leads into a roomy, baglike affair which extends a little way down each of his arms. This, of course, is the stomach of the starfish. It is quite loose and can be stretched to a surprising degree. We shall see presently how useful this arrangement is to the animal.

### The Starfish as an Acrobat

Now we will let him turn right way up and watch how he does it. He is not very nimble, for his skeleton, which is made up of a network of limy rods and plates, makes him somewhat stiff in his movements; so it takes him some little time to accomplish this gymnastic feat. First, he twists one or two of his arms, at the same time stretching his tube feet until some of them are able to touch the ground and grip it firmly with their suckers. The rest is easy. He goes on twisting his arms and wriggling his tube feet until, with a final strong pull, over he goes! This

## THE STORY OF THE SEA

is how the common starfish behaves. The short-armed variety is much more spry; he is quite a little acrobat. It is a funny sight to watch his antics when he has fallen on his back. Raising himself up on the tips of four of his arms as high as he can, he wobbles about for a bit, then suddenly flings his fifth arm over, turning a complete somersault. The whole performance takes less than a minute.

Starfish are not at all popular creatures. They are so greedy and so ruthless in their ways that they are a terror to all stay-at-home sea folk, who are not able to run away or swim off in a hurry when these ogres with their clutching fingers come creeping up to them. There is hardly anything a starfish will not eat, from a worm to a prickly sea urchin, and there is no animal it will not try to devour if it can manage to seize it with its deadly tube feet. It is shockingly greedy too. A young starfish will eat more than fifty clams half as big as itself in less than a week. Fishermen hate starfish, for time after time when they draw in their long lines, they find that a sprawling "five-fingered Jack" has swallowed the bait on the hook instead of the cod or whiting they were fishing for. Above all, starfish love oysters. Swarms of the tiresome things invade the oyster beds and devour the oysters wholesale; oyster growers lose thousands of dollars every year because of their thieving ways.

But how can starfish destroy oysters in this way? You would think that an oyster had only to shut itself up in its hard, shelly house and refuse to open its doors to anyone; the disappointed ogre would then be obliged to look elsewhere for its supper. But oh, no! The starfish does not worry. It calmly presses its

mouth against the closed edges of the shell, clasps the oyster in its arms, and starts to pull the two halves of the shell apart with its tube feet. The oyster resists, of course, and strains its muscles to the utmost to keep its doors fast against the ogre; and the two creatures engage in a desperate tug-of-war. But it is of no use; the poor oyster is doomed, for although it can stand a very strong, sudden pull, it is beaten by a long, steady one. It soon grows tired, its shell is forced open, and

the terrible starfish actually proceeds to turn it-

self inside out. It pushes its food bag out of its mouth and into the shell and wraps the oyster up in it! When the starfish has finished its feast and digested the oyster, it packs its bag back

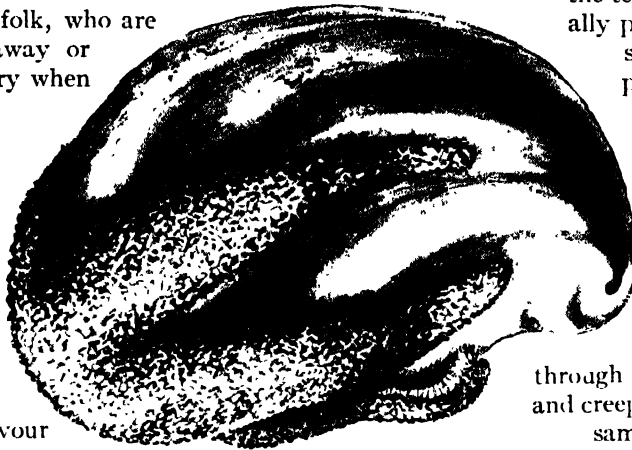
through its mouth again, and creeps away to play the same trick on another victim.

Should the starfish find a small oyster or a small mussel, he will not trouble himself to

pull the shell apart; he just swallows it as it is, and throws the shells out of his mouth when he has digested the tasty morsel within.

Fishermen are so much annoyed by the irritating behavior of the starfish that at one time whenever they caught a starfish at its tricks they would tear it in two and throw it back into the sea, thinking in this way to destroy at least a few of the troublesome things. But they were only adding to their difficulties; for if you tear one of these creatures in two, each separate half is capable of growing new arms and turning into a complete starfish. Instead of killing their enemies the fishermen were actually multiplying them.

While the new limbs are growing, the starfish are most strange-looking things. We may find one with a lopsided body—two



In this struggle between a clam and a starfish, the starfish is going to win. The creature likes oysters too. Forty-two thousand bushels of starfish were taken from Connecticut oyster beds in a single year; and they had caused a loss of over \$600,000.

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long arms and three stumpy fingers—living quite comfortably on the sea floor. Or it may even have a single long arm with four tiny rays growing out from it and no body at all! So little do starfish mind losing their arms that some of these strange creatures will snap them off themselves if they are irritated. They then proceed to grow new

ones, while four little rays soon begin to sprout

This starfish is right side up.



from the arms they have thrown away. These new animals look for a time like long-tailed comets instead of stars.

Few starfish have less than five arms, unless they happen to have just thrown a few away; but many species have more. The common starfish of the Gulf of St. Lawrence has six; others may boast seven or eight; and the sun stars have as many as twelve, thirteen, or fifteen short, pointed rays standing stiffly out all round their flat circular bodies.

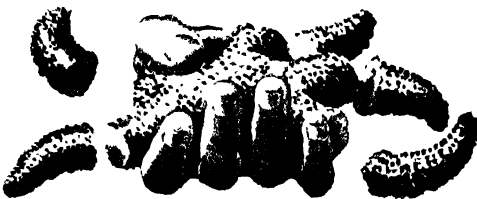
### Stars Two Feet Across

There are starfish of all sizes and colorings. Gigantic five-rayed stars measuring two feet across lurk in the deep waters off the western coast of North America; and even bigger fellows nearly three feet in diameter, with twenty-two rays, are met with still further out to sea. Plump little cushion stars about an inch across are found under stones and rocky ledges. There are orange stars, purple stars, red, pink, green, yellow, and even blue stars, while some are variegated. There are smooth stars and prickly stars covered with sharp spines; and there are some which have no suckers on their tube feet. Nevertheless, although the last-mentioned cannot pull the valves of an oyster apart, they can devour

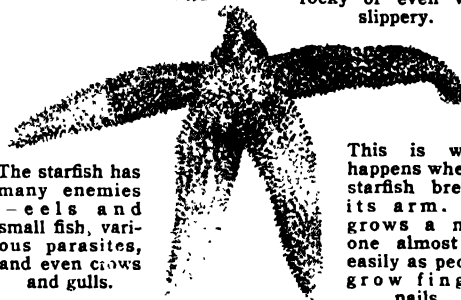
good-sized shellfish, for they have remarkably wide and elastic mouths and are able to swallow their unfortunate victim shell and all.

The picture just below shows why you can't catch the *Luidia* starfish. Forbes, the British naturalist, tells of trying to do so. He brought a fine specimen up in his dredge, and greatly hoped that he could get it out of the water whole by changing it to a bucket of cold water. For the *Luidia* does not usually break until it is above the surface of the sea. So he anxiously sank his bucket to the same level as the mouth of the dredge, and then, as gently as possible, proceeded to lift the little starfish into the bucket. Instantly the perverse creature began to vanish under the scientist's very eyes. Through every mesh of the dredge its fragments fled away. Desperately Forbes finally grabbed the biggest piece, for he could not bear to be cheated of his find entirely. But he found that all he held in his hand was the very tip of an arm, with its single eye on the end of it and the last straw came when the eye knowingly opened and closed in what the disappointed naturalist could only feel was a wink of derision!

So far as one can tell, a starfish never knows whether he is coming or going. The strange creature can move off—at the rate of six inches a minute—in any direction at all over any kind of surface, muddy or rocky or even very slippery.



The starfish has many enemies—eels and small fish, various parasites, and even crows and gulls.



This is what happens when a starfish breaks its arm. It grows a new one almost as easily as people grow finger nails.

Then there are the brittle stars, sometimes called "sand stars" or "snake tails," funny little water folk with round, flat, buttonlike bodies and five long, slender, wriggling arms, which they fling off at the slightest provocation. Try to catch one of these odd little beings by an arm and you will soon see why it is called a brittle star. With a quick, sudden movement it at once snaps off its arm and wriggles away in a hurry. Lift the star from the water and give it only the slightest squeeze and off fly all its five legs, leaving you with nothing but the tiny round body in your hands. It is most disconcerting!

Brittle stars are more active in their movements than the true stars. They creep about by wriggling their long arms, as their tube

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## THE STORY OF THE SEA

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Photo by N. Y. Zoological Society

Nature is a skillful artist when it comes to arranging her effects. Here is a beautiful grouping of corals and starfish and sea fans; and against that delicate background some little "four-eyed" fish, or chaetodonts (kē'tō-dōn), have consented to pose! If you will let your imagination color the whole, you will see that the

feet are quite small and have no suckers. Many actually walk upon their arms, raising themselves on the tips and moving them as if they were legs; or they may row themselves about, moving their useful arms like oars. Some of these curious stars bristle with sharp, delicate spines, which stand out at right angles on each side of the arms. The arms look like so many centipedes when the spines are writhing and twisting in their usual restless fashion. Other varieties are clothed with shorter, flattened spines that look like scales; and the tapering arms remind us of tiny lizards' tails, as they wave about around the body disk of the little star.

Stranger still are the "Medusa head" starfish, or "basket fish," as they are often called. Their five long arms are divided again and

bright little fish have really found a safe place to hide in. For they vie with the background in brilliance, and their two extra "eyes"—which are only the big spots near their tails—help to break up their outline so that at a little distance it would be exceedingly hard to tell what was fish and what was not.

again into numerous branches, which are often all twisted and matted together into a kind of net. Some of these peculiar starfish are fond of climbing up living corals, sponges, or sea fans and twining themselves about the branches of these long-suffering animals. Then, while holding on tightly with one or two of their Medusa-headed arms, they wave the others about in the water to catch tiny sea creatures that may come swimming by.

Brittle starfish of many kinds live at all depths of the ocean, from the shallows round the coast line to the deep waters far out to sea. Some burrow in the sand, some climb about the seaweeds, some wriggle themselves into small holes among stones and shells. Many make their homes on the coral reefs,



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where they twist themselves in and out of the crevices in the coral rocks.

Many of the quaint little things are brilliantly tinted. Some are one color all over, others display all the colors of the rainbow in their wee round bodies and waving, spine-clad arms. Many, too, are luminescent (lū'mī-něš'čnt); they shine in the dark like bright green stars.

### Arms like Graceful Feathers

There is one very lovely and rather rare little sea star called the "feather star." It is not very closely related to the true starfish or even to the brittle stars, although it belongs to the same class of sea creatures. They are called by learned folk "Echinoderms" (ē-kī'nō-dŭrm), from a Greek word which, when translated into plain English, means "prickle-skinned." Feather stars live in deep water. They have ten long, beautiful arms, like graceful, waving feathers; and on the back of the tiny body disk is a circle of curved spines like little claws, with which the pretty creatures anchor themselves to rocks or seaweed when taking a rest. If the feather stars are disturbed, they at once unhook themselves and away they go, traveling easily through the water by waving their feathery plumes.

### Orphans Cast into the Sea

Starfish are not, as a rule, good parents. They simply scatter their eggs in the sea and trouble no more about them. What becomes of their offspring they neither know nor care. Countless millions of baby starfish escape from these eggs into the sea every year. The little waifs are tossed about here and there in the currents, and most of them are swallowed by fishes and other sea creatures and never grow up at all. Just a few, however, manage to escape the sad fate of their brothers and sisters. At first they are not in the least like their parents; you would never guess that they were baby starfish if you saw them at this time. But after floating about for a bit at the surface of the sea, and feeding greedily on living things even smaller than themselves, they begin to alter in shape. Gradually their tiny round body disks are formed and their wee arms begin

to sprout. Then the young starfish sink down to the bottom of the water, where they spend the rest of their lives.

But a baby feather star does not behave in exactly the same way as other baby starfish do. At first it is, as they are, a tiny speck of a thing clothed with bands of fine hairs to enable it to swim about near the top of the water. But it soon sinks down and fixes itself to a rock or a frond of seaweed, and there it grows like a bud swaying on the end of a slender stalk. Presently its feathery arms begin to sprout and grow out, expanding like the rayed petals of a flower. At last it grows too heavy for its delicate stalk; so it breaks off and swims away as a perfect little feather star.

### "Lilies" That Eat and Drink

The feather stars belong to a very old and distinguished family of sea people. They are closely related to the beautiful "sea lilies" that spend the whole of their lives attached by their stems to a rock on the floor of the sea. There they bend their graceful heads, opening their arms wide to collect the food from the drifting currents. Sea lilies live as a rule in deep water, though some are found on the wave-beaten reefs of the West Indies, firmly fixed in the hollows of the rocks. These have only a very short stem.

One or two starfish do take care of their children. One small, slender, deep-red five-finger called the "eyed cribella" (krī-běl'á), clings to the flat side of a rock, humping herself over her eggs so as to make a kind of bell tent of her body. With this she shelters them and protects them from harm until they hatch. Then the tiny babies leave their thoughtful mother and swim away to fate or fortune in the great, wide sea. Some of the brittle stars keep their eggs in a little pouch. These babies are like tiny editions of their parents. They do not hurry off as soon as they are hatched, but cling to their mother with their spiny arms and are carried about with her until they are old enough to take care of themselves.

The funny little sea urchins are all related to the starfish. They climb about the rocks in the deep pools and on the coral reefs,

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bury themselves in the sand, tuck themselves away in holes, or creep along over the sandy floor deep down under the sea. The family name, "prickle-skin," fits them much better than their five-fingered cousins. For sea urchins are most prickly little creatures; they fairly bristle with spines and look for all the world like tiny hedgehogs who have forsaken the dry land and taken to a watery existence. That is to say, most of them do; for there is a whole tribe of these queer sea urchins, and they are by no means all exactly alike. Some are as round and prickly as chestnut burrs; others are almost as flat as cookies and clothed with a velvety coat of short, fine hairs. They are known by all sorts of different names—sea egg, cake urchin, heart urchin, mermaid's head, sand dollar, wheel urchin—in fact, every country and almost every locality has its own special names for these odd little sea people.

Although sea urchins do not look in the least like the starfish, the two families really are alike in many ways. They have the same kind of tube feet and carry a complete armory of tiny pincers scattered all over

them. They have, too, special filters, or water pores, through which fresh currents of water are constantly passing to the canals below. But the tube feet are not arranged in exactly the same way as the feet of the starfish; they are capable of stretching out far beyond the spines. Prickly sea urchins use them for locomotion, in con-

junction with their stiff, stout spines, which are attached by a ball-and-socket joint to the test or shell—in which the urchin lives.

The best way to find out how the sea urchins move, eat, breathe and defend themselves is to examine one of their wonderful little houses when the animal it formerly held is dead and the spines that covered it washed away. These "tests" are often to be found lying about, clean

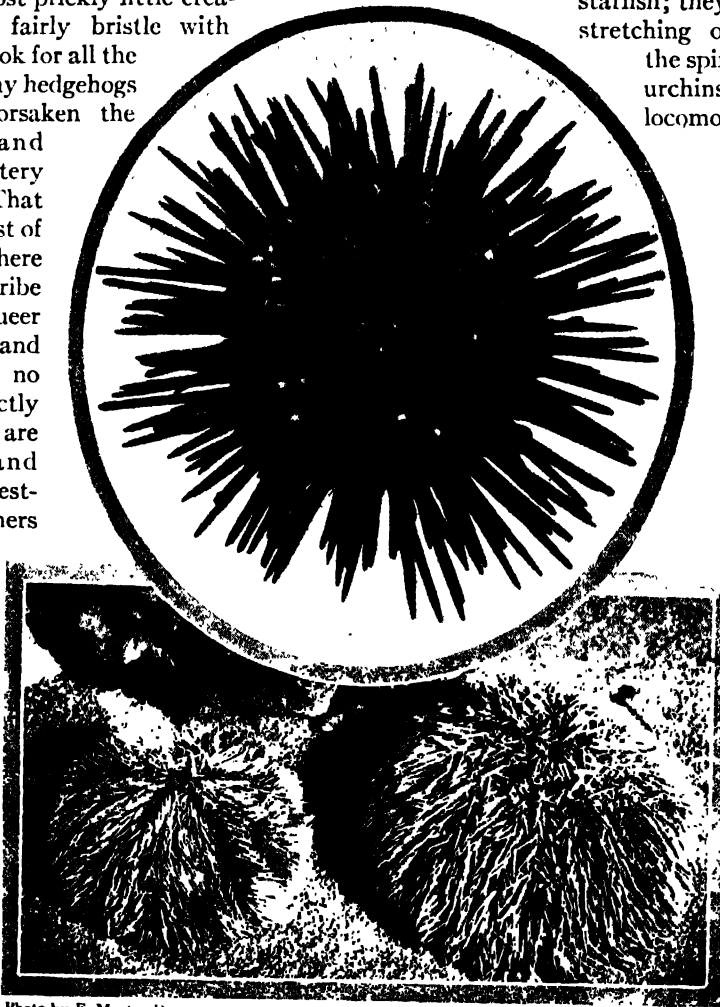


Photo by F. Martin Duncan

These sea urchins might well pass for mermaids' pincushions—at least until they began to move their spines about. In certain varieties that resemble the one in the picture at the top, the spines make very good slate pencils. You see they are really made of the same substance as chalk. The common egg urchins shown in the lower cut sometimes grow as large as six inches across.

and empty on the floor of the sea.

The test of the common egg urchin is often as large as a good-sized orange and looks as if it might be a model for the carved dome of some Indian palace. We can see that it is made up of a number of thin plates, all fitted perfectly together. At the top is a

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small round hole set in a kind of rosette composed of little shieldlike plates and knobs. One of the plates, which is pierced by a number of pores, is the water filter. The dome is divided by five broad bands covered with raised knobs of different sizes. These bands run from the rosette at the top all the way round to a large hole underneath; between them are five narrower bands pierced by rows of tiny holes. Through these holes the urchin, when it was alive, pushed out its tube feet. To the rounded knobs on the broad bands its spines were fixed in such a way that they could be moved and bent in any direction the animal wished. The round opening on the under side of the test was the mouth of the urchin. Sometimes we may find still projecting from it a wonderful little bony contrivance shaped like an old lantern. This is always called "Aristotle's (ăr'is-tōt'l) lantern," after the old Greek philosopher who first noticed and described the dainty little thing. The "lantern" is really the jaws of the urchin. It is filled with fine, strong, chisel-shaped teeth which work up and down inside the bony framework to chop up food for the little animal. They are also used, when the urchin is climbing about, to seize hold of things like seaweed and so help the creature to drag itself along.

The sea urchin's pincers are even more remarkable than those of the starfish. When closed they appear harmless enough; they look like tiny glistening bulbs on the end of slender spines, thickly scattered among the coarser prickles clothing the little animal. But only touch one of these innocent-looking things and in a trice it springs open, transforming itself into a formidable weapon with

three sharp curved blades which snap angrily, trying to nip and pinch anything they can catch hold of. The blades are not only sharp; their edges are cut up into fine teeth. They are moreover connected with a poison gland; so they sting as well as wound any small sea creature who is bold enough to attack the warlike little animal.

In addition to protecting the sea urchin when it is in danger from some enemy, the useful pincers serve as tools to keep the test clean and free from mud and sand. They

pick off every speck of dirt that falls upon the spines and tube feet and fling it away with a jerk. But this is not all. Some urchins that live in shallow water hold bits of seaweed, tinystones, and broken pieces of shell in their pincers so that they are practically hidden under these odds and ends. Dressed up in this disguise they move about intent on their own affairs, hoping to escape the notice of those hungry sea monsters who would gobble them up in

spite of all their prickles and snapping pincers.

The sand dollars that abound on the east coast of North America are pretty little urchins with soft, velvety coats of fine purplish hairs. They have no stout prickly spines, and their tests, which in some places are cast up in great numbers on the shore, are flat and smooth. Forming a star on the top of the "dollar" are the rows of perforations for the tube feet to come through. The tests of the wheel urchin are quite as flat and have a number of projections on one side that look like the spokes of a wheel. These prevent the little animals from sinking too far into the soft sand in which they like to lie partly hidden.



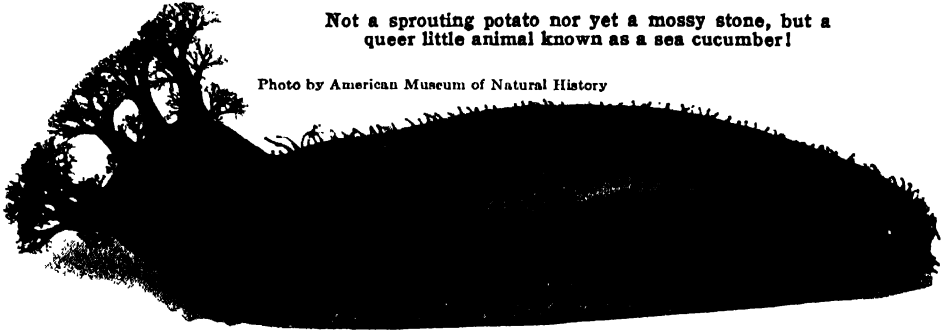
Photo by F. Martin Duncan

**Here is a heart sea urchin with all its spines gone. When it is alive it digs itself into the sand and leaves a chimney above it which it lines with mucus. Then it sticks certain of its tube feet up the chimney and proceeds, not only to breathe with them—for they serve as gills—but also to feel about with them for food.**

## THE STORY OF THE SEA

Not a sprouting potato nor yet a mossy stone, but a queer little animal known as a sea cucumber!

Photo by American Museum of Natural History



The heart urchins are even more retiring in their habits. They, too, have smooth coats, which suit their way of life better than prickly ones, for they dig right down into sand or mud, using their spines, which are curved and flattened, as trowels to scoop out their burrows. They leave an opening like a chimney to their burrow. Through this they obtain their food and the water to supply them with oxygen while they are living snugly underground.

The heart urchin collects its food in a very funny way. Some of its tube feet are very long and can be stretched up the chimney all the way to the sea floor. There they grope about and grab handfuls of sand with their fingerlike suckers. Then the tube feet disappear down the chimney and shovel the sand into the urchin's mouth. Sand, one would think, could not be a very satisfying meal; but there are always all sorts of tiny creatures and scraps of vegetable refuse mixed up with it, and the urchin seems quite content with this meager fare.

### Wee Creatures with Giant Cousins

There are many different kinds of these queer sea folk, wee things no bigger than a pea and giant urchins nearly as big as your head. These monsters live in deep water and have such long, strong spines that they can pierce through a stout leather shoe; so very few sea folk, or even human folk, are rash enough to interfere with them.

As a rule sea urchins are somewhat soberly clad in soft brown, purple, or olive-green tones; but others are very gay with orange, pink, green, or red tests and varicolored spines. They are really beautiful as they move about under the water.

If the sea urchins do not resemble their cousins the starfish in appearance, still less do they resemble their other "prickle-skin" relations usually called "sea cucumbers." Instead of a beautiful test covered with spines, these queer, dull animals are clothed with a leathery skin. As they roll lumpily about on the sea floor they look more like sausages than anything else.

### These Cucumbers Can Walk

A sea cucumber is, in fact, nothing more than a long, sausage-shaped skin bag pierced down its whole length with fine rows of tiny holes through which, when it wishes to take a walk, it pushes out tube feet, as a starfish or sea urchin does. Of course there is a digestive apparatus inside the bag. Round its mouth, which is at one end of the bag, it has a sheaf of really beautiful branched tentacles, the one adornment the creature possesses. With these it collects its food; but when not engaged in feeding itself the cucumber withdraws its tentacles inside its mouth, so that they are not always visible. Some of these animals have thick tentacles beset with short, stubby twigs. These are called "shield feelers." Others have slender tentacles divided into many long, thin branches and called "tree feelers." The shield-shaped feelers are used to shovel up mud and sand into the mouth of the animal; and the tree feelers are stretched out to fish for food while the cucumber clings with its tube feet to rocks or corals. Some of the creatures live always buried in the mud at the bottom of the deep sea, with only the two ends of their bodies projecting above ground, so that they are shaped like the letter "U." Others coat themselves with

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small stones, held in place by their suckers, and some have left off burrowing in the mud or dragging themselves over the floor of the sea and have taken to a life in the open water. The long feelers of these floating sea cucumbers are joined at their bases, forming a kind of web which supports the animal as it floats about in the ocean in much the way that a jellyfish does.

Although it has no test, the skin of the sea urchin is strengthened by a number of tiny plates of carbonate (kär'bön-ät) of lime that are imbedded in it. These plates are beautiful things shaped like wheels and shields and anchors, but they are so small that we can see them only through a microscope.

In their ways and manners sea cucumbers leave much to be desired. They are dull, sluggish things and move about as little as possible. But if irritated or if they do not feel well, many of them have an unpleasant habit of shooting out the whole of their interiors, so that they are nothing but empty bags. You would think the strange animal

had killed itself by this performance, but no, it grows a new set of internal organs and is then quite all right again.

One sea cucumber called the "cotton spinner" throws out a great mass of cottony threads from its mouth. This fellow is much disliked by fishermen, who declare that it creeps into the lobster pots and fills them with the disgusting sticky threads. This so alarms the lobsters that they sometimes fling off a claw or two in their excitement, and are thus quite spoiled for the market. The cotton spinners can alter their shape, too, stretching themselves out until they are like long, thin worms, or blowing themselves up with water until they are as round as a ball. Some, if you clutch them, will snap in two, and both halves will wriggle away. But sea cucumbers have their uses. They are caught in great numbers on the shores of the Malay Archipelago and on the Barrier Reef of Australia, and are then dried and cured and sold to the Chinese under the name of "trepang" or "bêche-de-mer" (bësh-dë mër). They are finally made into soup.



Photos by American Museum of Natural History and N. Y. Zoological Society

The gourdlike creature at the right is really a cucumber—but a cucumber of the sea. For the sprouts at one end are really tentacles around its mouth, and very useful they are for getting its food or helping it float through water. But it has feet too. They are the curious "buttons" along the under side, and are really

"tube feet" which the animal pushes out through holes in its skin. The starfish, in the center, possesses tube feet, too. But the little sea horse, at the left, has no feet at all. He is really a fish, and swims about with the fin that you see on his back. He anchors himself with his tail; and has any number of funny antics.

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# ***The STORY of LIFE in the SEA***

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## **Reading Unit**

**No. 8**

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### **CREATURES THAT NEVER LEAVE HOME**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

How the Trochus carries his house with him, 3-142  
How a sea shell is made 3-143  
How the soft mollusks defend themselves, 3-143-44  
The limpets, 3-144-46

Mollusks that drill holes through other mollusk shells for food, 3-146-47  
How some mollusks care for their young, 3-148-49

#### ***Things to Think About***

How does the Trochus shut the door of his house?  
What is the importance of its mantle to a mollusk?  
What enemies do mollusks have?  
In what way can certain mollusks injure large animals, including man?  
What mollusk can change its sex?

How do cannibal mollusks get at soft mollusks inside their shells?  
What enables sea snails to float as they do?  
What connection is there between parental care and the number of eggs produced by snails?

#### ***Picture Hunt***

Why is the whelk called a univalve mollusk? 3-142  
How many univalves and bivalves are shown in the color plate 3-146?  
What kind of sea shell is pre-

ferred by hermit crabs? 3-143-48  
Why is the cowrie used as money in some places? 3-145  
What is the value of an operculum to a whelk? 3-147

#### ***Related Material***

Why is Cliona a menace to oysters? 3-85-86

In what ways is the octopus related to the mollusk? 3-172

#### ***Summary Statement***

The mollusks are of interest to man as a source of food, as objects of beauty, and as creatures with interesting habits. The shell is made by the mantle as long as the animal lives. Some mollusks have a single shell;

some have a double, hinged shell. Wherever a mollusk goes, he drags his hard home along to protect his soft body. Certain sponges and other mollusks bore holes in sea shells and suck out the juicy victim.

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He is not very old, as ages go, but already he has an absorbing interest that he will keep through life. He has begun collecting shells. He will never tire of the hobby because every shell he finds will be different from every other and all will be of rare beauty. Of course he will never see all the different kinds the sea has to offer. But he will always be finding out more about them and about the strange creatures that have lived in them. We can guess from his expression that this latest find is a treasure.

Keystone View Co. of N. Y., Inc.



### CREATURES THAT NEVER LEAVE HOME

*If You Always Had to Carry Your House on Your Back, You Might Be as Little Known to Fame as the Dog Whelk or the Limpet*

"See what a lovely shell,  
Small and fine as a pearl!"

**O**F ALL the beautiful things in old Father Neptune's kingdom none are more lovely than the shells. "Pink and silver, purple and blue, tinted with many a rainbow hue," they lie scattered over the sandy floor of the sea and in every rock pool and coral garden. They cluster on the rocks, they are hidden in the tangles of seaweed, and swept up in thousands by the waves to be tossed carelessly at our feet.

All over the world, except in the ice-bound polar regions where no life can exist, some of these fascinating "treasures of the deep" are to be found along the coast. Of all sizes, shapes, and colors—spires and domes and turrets, cups and saucers and caskets—painted, sculptured, and ornamented in hundreds of different ways, there is no end to their wonderful variety. We seldom find

two that are exactly alike even though they may be of the same kind.

Here is a little "top shell" shaped like a circular tent, all pink and silver, with a charming pattern of lines and dots running round it in a spiral from its broad, spreading base to its pointed top. Through the doorway we can see that it is even more beautiful inside, for it is lined with dazzling mother-of-pearl that changes in color as we turn it.

The shell is empty now. But what of the little being who once lived inside it? Surely none but fairy hands can have fashioned such a dainty dwelling.

"Did he stand at the diamond door  
Of his house in a rainbow frill?  
Did he push, when he was uncurl'd,  
A golden foot or a fairy horn  
Thro' his dim water world?"

Well, the Trochus (trō'kūs)—for so he is

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called—may not be exactly our idea of a fairy, but it is true that he has a rainbow frill, a golden foot, and a fairy horn—or rather two horns. Altogether he is a delightful and most interesting little sea person.

### How the Trochus Bolts His Door

Let us look for a top shell with the little owner still living inside it. If we find one tightly closed by a round, glistening door we shall know the Trochus is at home. This door is called the “operculum” (ô-pûr'kû-lûm). It is a lovely little thing, a thin, half-transparent, horn-plate, winding round and round from the center, spiral fashion. But it is very strong. You may be surprised to hear that instead of being attached to the opening of the shell, like a door or a lid, it is firmly fixed to the

foot of the little creature within. This arrangement, although it appears rather odd, is really a most convenient one for the Trochus. No one can open the door when he is holding it shut by pressing against it on the inside with his strong, muscular foot. Whenever he wishes to take a walk he is ready to step out of doors without loss of time.

The Trochus has only one foot, but it is a very big one. It comes billowing out through the door, spreading out all around the little shell in a pale golden wave. One wonders how it is ever going to be packed away again!

The foot is followed by a well-shaped head bearing two slender horns and a pair of dark, beady eyes mounted on short stalks. Standing out on each side of the head is a

broad lappet bordered with a “rainbow frill” of fine rainbow-colored hairs. This pretty collar is really the edge of the cloak—or “mantle,” as it is called—of soft, filmy skin which lines the shell and is wrapped all around the delicate body of the little animal within.

All shell dwellers have a cozy garment of this kind. It is usually fashioned like a sack, with an opening for the head and foot to come through. Over the back of the neck it expands to form a little vaulted chamber

for the feathery or comb-like gills by means of which the little animal breathes. The rippling, wave-like movements of the fringe on the collar of the mantle send currents of water flowing through the gill chambers, where the life-giving oxygen in the water is extracted by the gills.

Having come out, or partially out, of its shell, our little Trochus marches off in a leisurely way to the feeding ground, gliding over the sand and rocks on its strong, broad foot, moving first to one side and then to the other as it goes along. Its favorite food is soft seaweed or fine sea grass; for the little creature is a strict vegetarian. It rasps away industriously at the tender fronds with its rough tongue, which is like a long narrow ribbon covered with rows of sharp prickles. Having finished its repast, the Trochus goes indoors again. Its head and its horns and its long foot disappear in a miraculous way through the little opening of the shell, and the door is firmly shut against intruders.

Now we are all more or less given to calling things by their wrong names. For example,



Photo by American Museum of Natural History

The whelk is a good example of what we call a univalve mollusk; that is to say, his shell is single, instead of double like an oyster's. And his shell is not only his house; it is a living part of him, just as our hair or nails are a part of us.



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## THE STORY OF THE SEA

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Painted Especially for This Work

Here are only a few of the gayly colored shells with which Father Neptune decorates his domain. The ones above are all empty; their neat little builders are dead. But the sea is full of inhabited ones just as beautiful

and a good deal more varied. For the little creatures that hit on this plan for protecting their tender bodies are very numerous. There are over sixty thousand different kinds of them.



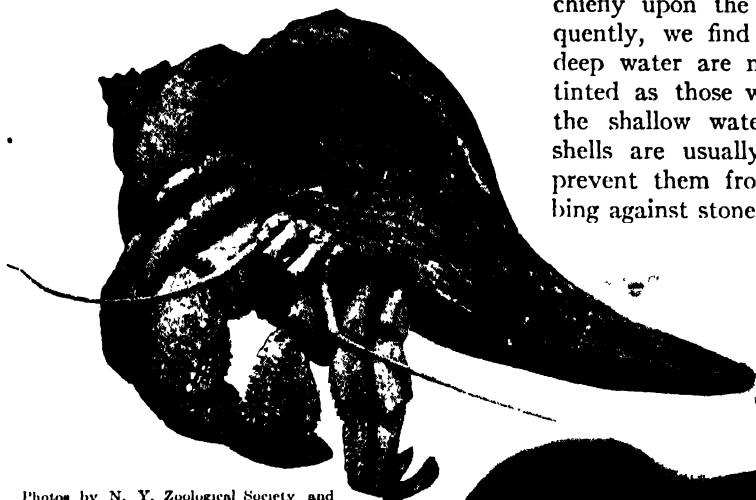
## THE STORY OF THE SEA

we speak of a shell dweller as a "shellfish" when of course it is not a fish at all. It should be called a "mollusk" (mōl'ŭsk), a name not at all difficult to pronounce or remember. Then we call the shell of a mollusk its "home" or its "house." Well, this is not so bad, since the little creature certainly does live inside it. But the shell is

or broken. This work the mollusk accomplishes with the edges of its mantle—or sometimes with its foot—which are provided with special shell glands for the purpose.

### How Shells Get Their Colors

The beautiful colors of shells depend chiefly upon the action of light. Consequently, we find that mollusks living in deep water are not as a rule so brightly tinted as those who make their homes in the shallow water near the coast. The shells are usually protected by a skin to prevent them from being injured by rubbing against stones or worn by the constant



Photos by N. Y. Zoological Society and American Museum of Natural History

Whether the toothsome mollusk lives in fresh water or salt, he always has hungry enemies after him. In the picture above you may see the lazy hermit crab, which likes to make himself at home in a whelk shell, like this one, instead of making a shell of his own. The hermit crab lives in the sea. The other picture shows the eel pout, a curious inhabitant of certain rivers. It too is always on the hunt for a nice juicy mollusk for its dinner.



more than a home; it is actually part of the mollusk—just as our bones are part of ourselves. If we pull it out of its shell we shall kill the little thing. Single shells, like the shell of the Trochus, the whelk, or the periwinkle, are coiled round and round a central pillar of solid shell. To this central pillar are attached the strong muscles by means of which the mollusk pulls its foot back into its shell. The shell is made by the animal itself from the carbonate (kār'bōn-āt) of lime it extracts from its food. It enlarges it from time to time as it grows, and mends it or even puts a patch in it, if it is cracked

movement of the sea. This skin may be quite thin and transparent, or thick and opaque (ō-pāk')—able to keep out light. In the latter case it hides the color of the shell.

Mollusks are such soft, tempting morsels that they would have a very bad time if they had not their pretty shells to hide in. Many are gobbled up by rats, raccoons, and foxes, who come down to the shore when the tide is low to hunt about for something to eat. Sea birds are always on the watch to snap them up as soon as the sea goes down

## THE STORY OF THE SEA



For a long time this coyote will have to stand here wishing he had never seen an abalone shell! And it

is no comfort to him that the beautiful lining of the shell he is caught in is often made into jewelry.

and leaves the poor things uncovered; and fishes, starfishes, and crabs prey upon them beneath the water.

Many of the smaller and most lovely shells are so frail they can be crushed in a moment. Others are so thick and hard it is practically impossible to break them; and some are so hedged about with stiff, strong spines that they are as dangerous to tackle as a prickly hedgehog.

### Clowns among the Shell Fish

Mollusks have many ways of defending themselves although they do appear helpless. One pretty, delicate little thing called the "carrier shell," having no spines of its own, collects the empty pointed shells of other mollusks and glues them on its own house. Another one covers its shell with small stones and prickly bits of coral. The "cone shells," which are wonderfully colored and polished and live on the coral reefs, have a poison gland in their tongues. When they are attacked they bite their enemies sharply, inflicting painful and often dangerous wounds. The big "wing shells" and "fountain shells," which also live on coral reefs, attempt to escape from their foes by leaping and bounding about like performing acrobats. Some of these shells weigh four or five pounds. To see the great heavy things springing about with such agility is very funny.

It is by no means always safe to attack a big mollusk, as heedless sea birds and small four-footed beasties on the lookout for a tasty supper occasionally find to their cost.

A bird is sometimes caught by its foot and held prisoner by a giant limpet; and a rat who has rashly pushed its lip under one of these huge shells may be trapped in the same way. Even a coyote (*kī-ō'tē*) has been seen struggling with the tip of its muzzle clamped fast to the rock by a great "ear shell."

Limpets are not particularly beautiful, but they are interesting creatures with a character of their own. Because a limpet has no door to his house, he cannot shut himself up in it as a *Trochus* can. But he gets over this difficulty by fixing himself firmly to a rock with his great foot, which acts as a sucker and fills up nearly the whole of the space underneath his tentlike shell. There is not a crack left between the shell and the rock through which an inquisitive claw or snout can be pushed. Indeed, the shell often fits so exactly into a shallow pit worn by the pressure of the limpet's foot that it appears to be imbedded in the rock. It is no use trying to pull a limpet off the rock, for that foot of his has such extraordinary muscular power that he can resist a pull of sixty-two pounds—nineteen hundred times his own weight!

### How to Argue with a Limpet

Yet in spite of their powerful muscles the limpets are not always successful in defying their foes. Cunning rats have discovered how to jerk them off the rocks with a sudden, quick movement of strong jaws; and the oyster catcher dislodges them, if they are not too big, by hammering away at one side

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of their shells with his strong, wedge-shaped bill.

Limpets are very methodical creatures; they have their regular times for resting and feeding and always behave in the same way. All day long they cling to the rocks, perfectly motionless. Then as soon as it begins to grow dark they come to life and march off with much solemnity to their feeding ground, following exactly the same path night after night. They feed on seaweed, rasping steadily away at it with their rough tongues until dawn. Then the limpets troop home again, and with a "click" each one settles itself down on its own particular spot from which, if left in peace, it will not budge till feeding time comes round again.

The limpet has a marvelous tongue. It is very long and narrow—often longer than the shell itself—and covered with hundreds of sharp teeth, like tiny glassy hooks, arranged in regular rows down its entire length. The front teeth, which of course have the hardest work to do, are constantly wearing out. Their place is then taken by those on the next row. Yet the strange tongue does not get any shorter, for it grows up from the root as fast as it is worn down in front, and the limpet has always a good supply of sharp teeth ready for use.

Besides the true limpets there are many other mollusks with limpet-shaped shells. The "keyhole limpet" and the "split limpet" live low down on the shore among the stones. The first is distinguished by having a small hole, like a keyhole, on the top of its shell; and the second looks as if someone had snipped its shell with a sharp pair of scissors.

Then there is the "cup and saucer limpet," which has a second, smaller shell fixed in the center of the larger one; this makes an excellent cup and saucer when it is turned upside down. The "nightcap," or "fools-cap," limpet is a rather rare little mollusk, like a tiny French cap of liberty. It hides away among the rocks and stones which are always covered with water and it never ventures ashore, to come to grief there.

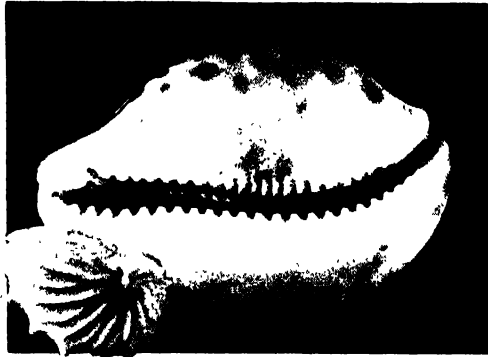


Photo by American Museum of Natural History.

The big shell above is a cowrie shell, famous all over the world for its high polish and handsome markings. A golden-red variety in the Pacific is worn by the native chiefs on some of the islands as a sign of their rank. And in parts of Africa, cowrie shells are precious enough to be used as money by the natives—though of course a single shell won't buy much! The tiny shell in the picture belongs to the paper nautilus, or argonaut. It is not a real shell, for it is not a part of the creature. Two of the animal's arms manufacture the little chalky bowl in which the creature nestles. It is not attached to its home, as a real shellfish is, but holds itself in with its two arms. The little nautilus is distant cousin to the octopus.

But strangest of all is the American slipper limpet—or chain limpet, as it is sometimes called—one of the quaintest of little mollusks. For the first year or two of his life, the little creature is fairly free and leads a roving existence, wandering as he pleases among the stones and rocks covered by the sea. We say "he," for curiously enough a young slipper limpet always belongs to the male sex—no "young lady" slipper limpets have ever been found!

As he grows older the limpet also grows wiser. He gives up

his restless ways and seeks a quiet spot where he may pass the rest of his life in peace and comfort. His choice is usually a shell, an oyster shell if possible; or he may climb up on top of another slipper limpet and calmly settle down. Presently another limpet comes along and climbs on top of both. Then another and yet another follows his example, until from twelve to fifteen of these queer little animals are all sitting one on the top of another making a long chain of limpet shells!

But this is not the end of the story. Having changed his way of life, the limpet now proceeds to change himself. He takes a short rest, grows somewhat larger, and finally turns himself into a "lady limpet"!

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Well, we know that all sorts of odd things happen in the sea world but this surely is one of the strangest of all.

### Their Babies Are Always Boys

The funny little creature now becomes very busy. She—for we must now change the limpet's title—makes a great many little skin bags—about fifty or sixty—fills them with eggs, then fastens them all together in a bunch, and sits on the top of them. In due time the eggs hatch and the young ones—all of them boy limpets—wander off to seek their fortune in the great water world.

Creeping slowly over the stones or clinging to rocks under the water we may come upon another little mollusk, which at first sight we might easily mistake for a long, flat sort of limpet. It certainly "clings like a limpet"; but with a good pull it is not difficult to dislodge the little creature. Then you will be surprised, for immediately it rolls itself up into a ball like a wee armadillo. So it is not a limpet after all; a limpet does not behave like that. It is a "coat of mail" shell, or a "chiton" (kī'tŏn)—for of course it must have more than one name. Its shell is made up of eight separate pieces that fit neatly together, overlapping one another like the tiles on the roof of a house or the steel plates in a suit of armor worn by knights of old. The chiton is so extremely shy and nervous that nothing will induce it to unroll again until it is satisfied that all danger is over for the time being. Then slowly and cautiously it straightens itself out and creeps off to hide under the nearest stone or overhanging rock. If no rocks or stones are available, the timid little thing will try to wedge itself into the soft sand or

mud. Any hiding place will do, for in spite of its coat of mail the chiton is anything but courageous.

This little mollusk is a peculiar animal in more ways than one. It has no head worth mentioning and no tentacles, but it has a broad, flat foot, a long tongue like a file, and several thousands of the most extraordinary eyes, called "shell eyes," scattered all over its armor-plated back or sometimes arranged in regular rows. These shell eyes look like tiny black dots and refract light as if they were made of glass

or crystal. In addition, many chitons are almost surrounded with bunches of bristles, which stick out all around the shell like paint brushes. Others are beset with stiff spines; and some conceal their armored plating under the folds of their mantles.

Not all mollusks are such harmless, inoffensive creatures as the pretty little top shells and the slow-going limpets. You

would be surprised if you knew how many of these shell dwellers are really cunning rascals that live by preying on helpless sea people, including many of their own unfortunate relatives. All the whelks are cannibals—the great whelks, the dog whelks, and the Nassas (nās'ā), the pretty little Naticas (năt'ī-kā), or sea snails, the beautiful cowries, the curious pelican's foot, as well as many others we have no time to think about just now. But we should know these rogues when we meet them. Look at the lip of the shell. If it has a distinct notch in it, it is the home of a cannibal mollusk. But if it is smooth and even all around like the lip of a top shell or a periwinkle, its owner is a harmless vegetarian that lives on seaweed and things of that sort.



Photo by F. M.

It is hard to believe that sponges or sea snails can bore through solid shells to get their food, as they have done here.

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The Natica has a smooth, round, highly polished shell, sometimes milky white, sometimes flushed with pink or yellow and marked with splashes of chestnut red. It lives in the sand in shallow water, and spends its time hunting about for the little double shells that lie buried just below the surface.

### The Natica Follows Its Nose

Now the Natica is quite blind, but that causes it no inconvenience; it can find its way about well enough and has no difficulty in discovering where its victims lie hidden. It simply smells them out. The foot of the little creature is enormous. When it is extended, it swells out all around and ruffs up until the shell is almost lost to view in its folds. The front part of the foot curls upward, forming a shield which completely hides the animal's head; only its two little horns are to be seen projecting above its foot when the Natica walks abroad. Slowly and cautiously the cunning little creature marches along, plowing up the sand as it goes with its great foot, making a deep furrow in which it is almost buried. Only the top of its shell is visible from above, as it tacks about in search of something good to eat.

### The Wicked Whelk

Presently the Natica stops. It has unearthed a victim. With calm deliberation, for it is never in a hurry, it covers the poor thing with its foot and proceeds to drill a neat, round hole in its shell with its long, rasping tongue. Then pushing the tip of its long snout through the hole, the wicked little animal proceeds to devour its prey with much enjoyment.

The whelk is

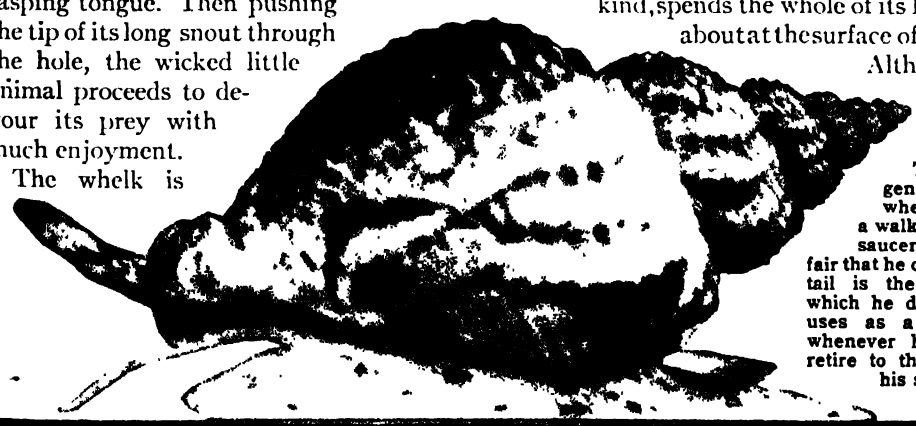
every bit as bad as the Natica, if not worse, for it is bigger and stronger and so the more able to attack larger, tougher shells. Its drilling tool is concealed in a long, flexible proboscis (prô-bôs'is)—rather like an elephant's trunk—which, as it crawls about on mischief bent, it waves aloft defiantly in front of its head. All the whelks have this extraordinary proboscis—and they are all wicked alike. They climb on top of limpets, ear shells, and mussels, drill holes in the shells, and suck the helpless creatures out of their houses. Large whelks sometimes do a great deal of damage to the oyster fisheries in this way. But the tables are turned on the raiders now and then and they themselves are devoured by other sea creatures in search of a meal.

### When Starfish Meets Whelk

For instance, a starfish intent on an oyster supper, may find that a big whelk with the same bright idea has arrived on the scene before him. The starfish is so pleased to meet him that he clasps the whelk in his arms and—and—well, you know the way of a starfish. When he says "good-by" and creeps away, the shell is empty! Big crabs, too, crush the mollusks in their powerful claws; catfish crunch them up with their strong teeth; and codfish swallow them whole. So the wicked whelks do not have everything their own way.

One of the daintiest little mollusks is the beautiful violet sea snail which, instead of creeping over the sea floor like most of its kind, spends the whole of its life drifting about at the surface of the ocean.

Although it is



This shapely gentleman is a whelk out for a walk. The little saucer-shaped affair that he carries on his tail is the operculum, which he draws in and uses as a front door whenever he wants to retire to the privacy of his shell.

## THE STORY OF THE SEA



Photos by American Museum of Natural History and F. Martin Ducaud

The big empty shell above was once the home of a whelk; and so were the ones in the upper left-hand

corner, though now some hermit crabs have moved in. In the upper right-hand corner is a cluster of whelk eggs.

commonly called a "sea snail," its real name is "ianthina" (i-ăn'thĩ-nà), which is so pretty that it suits the little sea rover much better. Ianthina's shell is very thin and delicate and a beautiful deep blue color. Its body is like that of other mollusks. It has no fine or feathery feelers to buoy it up in the water, yet the little creature does not sink, for it is attached to a wonderful little raft that keeps it afloat on the surface of the deep sea. Ianthina constructs this ingenious little raft from a sticky stream of silvery mucus (mũ'kũs)—like the trail of a land snail—that flows from its foot. In this it contrives to catch and entangle a quantity of air bubbles to make it light and buoyant. This airy float is not only a buoy; it is a nursery as well, for underneath it the industrious mollusk carefully suspends row upon row of wee, transparent eggs. Then, when it can carry no more, the little raft with its precious freight is set adrift and ianthina makes a new one.

Then there are the wing-footed mollusks, often called "sea butterflies"—tiny sea folk who live always in the open sea, swimming

merrily about by means of the fluttering movements of their "wings." These are really two thin, winglike outgrowths from the foot. Some of these mollusks have delicate shells, others have none. They sometimes congregate in such immense swarms in the surface waters in various parts of the world that the sea is "as thick as pea soup" with them! Great times these for hungry fishes, who gobble up the wee sea butterflies wholesale and have a royal feast.

### Queer Nests for Eggs

Shell dwellers on the whole are shockingly careless parents. But then, as they mostly have several thousand children at one time, they could hardly be expected to look after them all. Their eggs in many cases are simply broadcast into the sea or left lying about on the sand, stones, or seaweed. But some mollusks do show a little more consideration for the welfare of their young ones. They either deposit their eggs in sheltered spots where there will be at least a fair chance of their developing, or provide the eggs with some sort of protection until they



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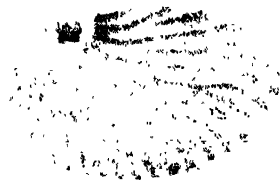
Photo by An \_\_\_\_\_ of Natural Histo

**Sharks are among a shellfish's worst enemies, for they eat every one they come across. Here are two strange**

**sharks called "hammerheads." The head has grown out at either side, with an eye at the end of the knob.**

are hatched. Top shells glue their eggs to the under side of stones and seaweeds. Natica mixes sand and mucus into a kind of thin cake and deposits its eggs in this container, which is coiled in a spiral form and looks like a thick piece of sandpaper. The common whelk makes a great many little papery bags to hold its eggs and then joins them all together into a ball as big as an orange. The dog whelks attach their eggs to breakwaters and fasten them in sheltered nooks in the rocks, where they hang in little clusters and look like pale pink grains of rice, each one set on a tiny stalk.

When the babies escape from their nurseries they are, with few exceptions, lively little creatures, not in the least like their parents. They swim gayly about for a time, waving their two tiny finlike flaps, which are bordered with fine fringes of hair. Most of them are swallowed by the fishes; but some sink down to the sea bottom and grow up according to their kind. Others are carried far and wide by ocean currents, and may even travel into foreign waters before they finally settle down. In this way many different tribes of mollusks are spread abroad in the kingdom of the sea.



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# ***The STORY of LIFE in the SEA***

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## **Reading Unit No. 9**

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### **CREATURES WITH ONLY ONE FOOT**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

How a bivalve uses its foot, 3-151  
How a bivalve gets fresh air, 3-152  
The behavior of a razor shell or solen, 3-153-54  
Mollusks that bore tunnels in

wood, 3-154-55  
The mussels and scallops, 3-156-57  
Oysters that have a million babies, 3-157-60  
Where pearls are made, 3-160

#### ***Things to Think About***

How do the mollusks escape enemies?  
How can the razor clam retreat into its burrow so fast?  
How is the pholas adapted to drilling holes in rock?

To what remarkable use does the teredo put its two shells?  
Since one oyster may produce more than a million eggs why is not the ocean filled with them?

#### ***Picture Hunt***

Which organs in a clam resemble those in man? 3-152  
What organ does the piddock use to make holes in rocks? 3-154  
How does the scallop swim? 3-

157  
What does the soft clam do for protection? 3-158  
Why should we not collect oysters during the summer? 3-159

#### ***Related Material***

What terrible enemy do bivalves have? 3-132

What mollusk cannibal kills and eats other mollusks? 3-147

#### ***Leisure-time Activities***

PROJECT NO. 1: At low tide search the sea beach for bits of wood that are riddled by teredo,

the "shipworm." Try to locate the mollusk and discover how it drilled the hole.

#### ***Summary Statement***

Bivalves have two shells for protection against their enemies. Since shells may be crushed or drilled through or gobbled up by starfish and fishes, the bivalves

can use their feet to dig into rocks or sand and so keep out of sight. A tiny siphon may project above the sand and send water in and out of the mollusk.



Of course he is safe in going to sleep behind that mighty fort! And you can see for yourself that the standard has not been shot down. It still stands proudly above the topmost battlement. But a more

relentless force than the enemy will come to wake him up. It is the tide that creeps nearer with every moment that passes. When it finally attacks the fort, he will find that waking up is very wet work indeed.

### CREATURES *with* ONLY ONE FOOT

*And a Strange Foot at That, for When Its Little Owner Is Tired of Walking on It, He Uses It for a Door, Which He Locks Up Securely on the Inside*

**M**OLLUSKS that have only a single shell are called "univalves" (ū'nī-vālv); those with a double one, "bivalves" (bī'vālv). Bivalves are very simple creatures compared with their univalve relations. They have no heads, no tongues, and no teeth; they are just soft, plump little bodies which are much too tempting to hungry sea creatures. But every bivalve has a mouth and a pair of lips to feed with, a pair of gills to breathe with, and an enormous soft mantle—often beautifully colored and fringed—to wrap up and protect its delicate body. It has a foot, too, as a rule, though it is seldom used for locomotion; for bivalves for the most part are stay-at-home folk and are not given to wandering about like their restless univalve cousins. Many, indeed, pass all their grown-up days lying quite still on the self-same spot, which seems a very dull and uninteresting thing to do. However, dif-

ferent creatures have different ways of enjoying themselves; the simple bivalves are content so long as they have enough to eat and are left in peace by the other inhabitants of the sea.

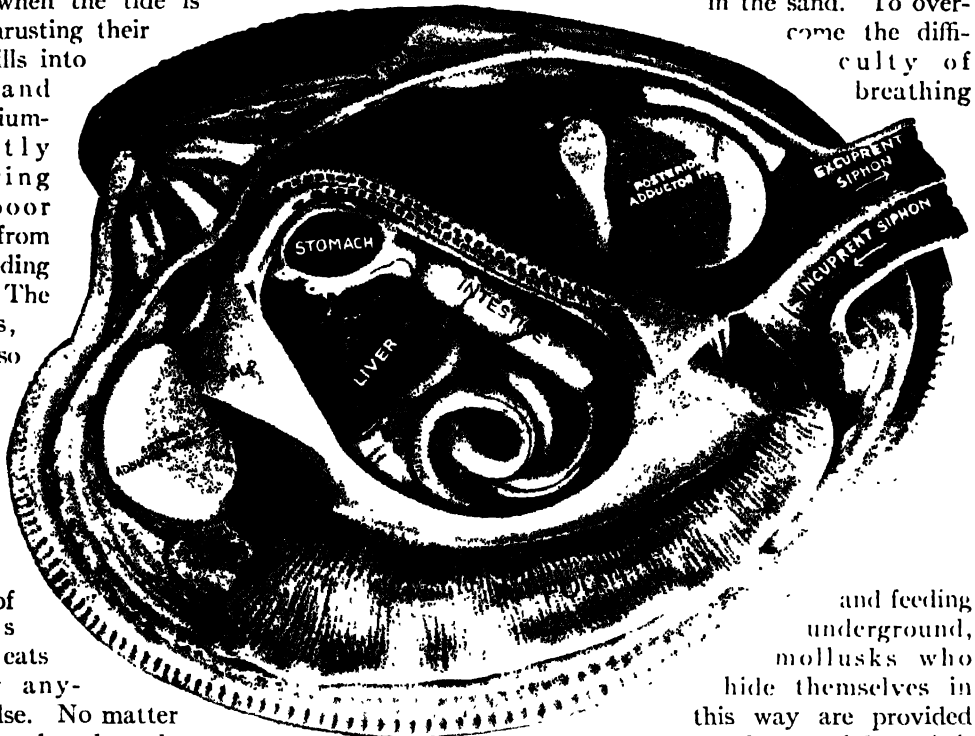
#### A Creature with a Single Foot

But all the same, a bivalve's foot is a most precious possession. It can be used as a spade, a boring tool, or a spinning machine according to the particular requirements of its owner. It may be very big and muscular or small and feeble. In some cases the foot has disappeared altogether and the bivalve has to manage without one. Here and there we find an excitable little bivalve that can hop and skip and bound away when it is threatened by an enemy, but this is an exception to the rule. Most of the mollusks rely for protection chiefly on the double doors to their houses, which they shut up

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at the first hint of danger. But their shells may be crushed by strong teeth or claws, forced open by the tube feet of the starfish, or drilled through by the wicked whelks and Naticas. Many of the timid animals retire underground, hoping to escape notice by burying themselves in the mud or sand. Yet even then they are not always safe. Wading birds run about excitedly on the shore when the tide is low, thrusting their long bills into the sand and triumphantly dragging the poor things from their hiding places. The walrus, too, is so

Now when one of these little creatures is lying on the floor of the sea, it has only to open its valves, and currents of water, set up by the rippling movements of the fringe on the edge of the mantle, carry food to the mouth and oxygen to the gills. So the mollusk has everything it needs to make it happy and contented. But this simple arrangement does not answer if it is buried in the sand. To overcome the difficulty of breathing



fond of clams that he eats hardly anything else. No matter how deeply they bury themselves, the old rascal finds them and digs them out with his long curved tusks. Really, these harmless little sea folk are very hardly used.

The bivalve mollusk rests in its home with its mouth towards the edges of the shell and its back against the elastic hinge which fastens the two halves together. Its mantle is arranged in two soft folds to right and left. Between the folds and the body of the little animal the gills are suspended, one on each side. Two strong muscles are attached to the shell, and by contracting or relaxing these the bivalve opens or shuts its door as it pleases.

Photo by American Museum of Natural History

The clam has a good many of the organs that you and I have, but his foot we should hardly recognize. Notice the size of the muscles that hold the shell together, and see the delicate mantle with which the shell is lined. The gills are especially important, for not only does the animal breathe through them, but they help to set up a current of water that brings all kinds of minute particles of food to his mouth.

and feeding underground, mollusks who hide themselves in this way are provided with two tubes, or siphons (sif-ſon), which can be pushed up to the surface. The water flows down one of these tubes and is carried away by the other; so a constant circulation is kept up and all is well with the cautious little animal in hiding down below.

The European cockle has a long sturdy foot that can be used both for digging and hopping. It is a handsome little creature with a strong, fluted shell and a bright, orange mantle, while its foot, which has a bent knee and a hooked and pointed toe, is a brilliant scarlet. Large numbers of cockles live together in a neighborly way, buried side by side in sandy bays and sand banks round the coast.

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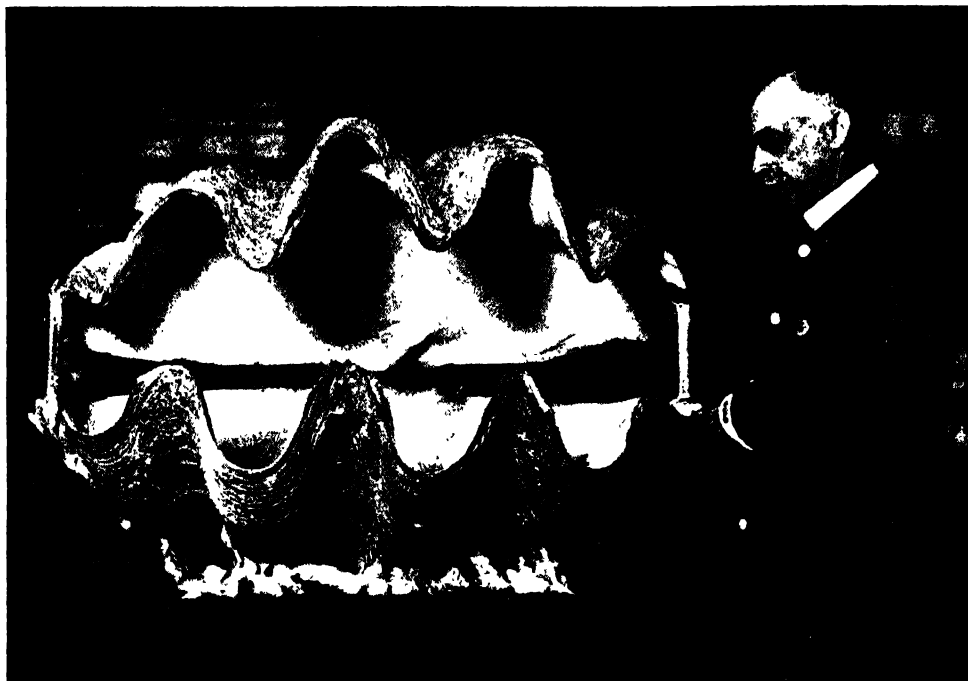


Photo by American Museum of Natural History

As big as a trunk and yet just a shell! But think of the size of this giant "bear's-paw" clam! He must have weighed several hundred pounds. The inside of

his shell is pearly white, but the outside is gorgeously colored, for its owner must pass unnoticed among the brilliant corals of the Great Barrier Reef in Australia.

When digging itself in, the cockle straightens its foot and thrusts the pointed tip down into the yielding sand as far as it will go. Then turning up his toe again, he hooks it firmly in the ground, contracts his muscles, and so, in a moment, is dragged shell and all down below.

### When a Cockle Gets Excited

Cockles much dislike being left high and dry; so they mostly live beyond low-water mark. But now and then some of the little mollusks who have buried themselves too near the shore find themselves uncovered by the low spring tides. Afraid to show even the tips of their siphon tubes, all the little cockles hurriedly sink as far into the moist sand as they can. There they "lie low and say nuffin'," hoping no one will discover them in this dangerous position before the turn of the tide. When at last the sea comes creeping in again, the cockles grow so excited that they can hardly restrain themselves. Many

actually come out of their burrows and with a hop, skip, and a jump go bounding merrily down to meet the water. They take flying leaps of a foot or more. To see these comic little creatures springing about on their scarlet toes, their heavy shells rocking from side to side, is one of the funniest sights imaginable.

These merry little bivalves have the ill luck to be edible, though they could hardly be called a delicacy. At the mouth of the Thames, in England, the gathering of them makes quite an industry. They usually are cooked before they are sent to market.

### The Hermit Solen and His Elevator

The solen, or "razor shell," as he is sometimes called, has an extraordinarily long and strong foot. He never hops about on it, however, but uses it simply as a handy tool with which to tunnel out a deep hiding hole for himself in the sand or on the muddy stretches at the mouths of rivers.

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This burrow is often two or three feet deep. The solen never leaves it of his own accord; but he is a restless fellow and spends a great deal of his time climbing up and down his shaft. When the tide has been out some time, he will often come up to the surface and push two or three inches of his shell above the ground, as if he were looking out to see where the ocean had gone.

The razor shell in which the solen lives is long and narrow, either quite straight or slightly curved. It is covered with an olive-green skin mottled with bright orange, and is really very handsome. But as the skin is very thin and the solen is always scraping it against the walls of his shaft, it is generally rubbed off in several places and looks very tattered and untidy.

The solen moves up and down his shaft like an elevator worked by foot power instead of by electricity. This is how he does it. When he wishes to descend he stretches out his foot as far as it will go. His pointed toe immediately swells out like a bell clapper; this wedges it firmly in the shaft. Then by a sudden contraction of the muscles, the upper part of the foot shrinks, pulling the shell down with a jerk. All this happens in a flash. By repeating the maneuver two or three times the solen is shot from top to bottom of his shaft in next to no time. When he wishes to rise again to the surface he has only to reverse the order of the proceedings—and there he is up at the top again! Long though it is, this peculiar foot is so soft and elastic that it can be drawn up and packed away in the shell when the solen is not employing it as a burrowing tool or as an elevator.

Some bivalves, instead of burrowing into sand or mud, tunnel into old timber. Others scoop out little caves in rocks, boulders, or corals, where they live apart, like hermits in their cells, taking no interest in all the exciting happenings in the great water world.

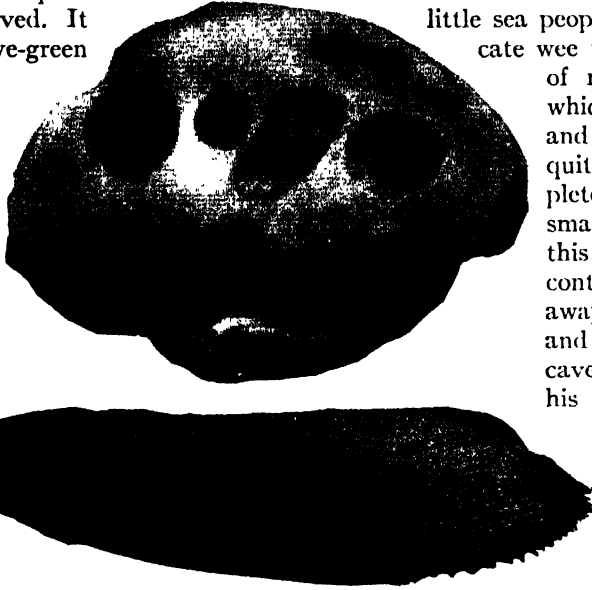
### How the Piddock Bores into Rock

The pholas (fó'lás), or piddock—for like so many sea creatures it has more than one name—is one of these retiring little sea people. He is a delicate wee thing with a pair of milk-white shells, which are very thin and brittle and not quite big enough completely to cover his small, soft body. Yet this frail little fellow contrives to scrape away the hard rock and bore out a roomy cave in which to pass his days in peaceful seclusion.

Exactly how he accomplishes this work was for a long time a mystery. But now the secret is out. The pholas does it with his foot, which, although it is so soft and almost as transparent

as ice, is shod with a layer of sharp flint crystals that convert it into a perfect file. With this cunning tool the pholas scrapes away so hard that after a while the teeth of the file are worn down. But this does not daunt the determined little worker. He merely takes a short, well-earned holiday and while he is resting, the wornout crystals are replaced by a new set. Then with renewed vigor he rasps away at the rock as energetically as ever.

When his task is completed the pholas lies at the back of his cave with the tips of his two long siphon tubes pushed out just beyond the doorway. He is fairly safe there, for the entrance is too small for most maraud-



Photos by F. Martin Duncan

Here the little piddock has been caught at work digging into a solid stone. The lower cut shows him exactly life-size. One wonders where so tiny a creature gets the strength to bore into the solid rock.

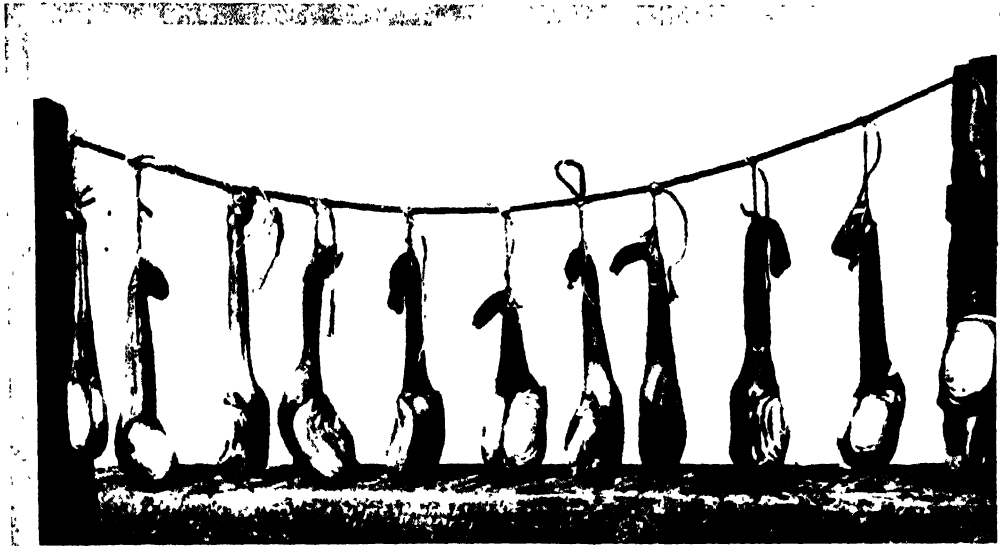


Photo by Nature Magazine

It is hard to see why these outlandish clams should bother with their shells at all. Certainly they have quite outgrown their little homes, for the queer creatures are at least three feet long and may weigh over

six pounds. They are called goeducks—probably from some Indian name—and live in the sand along the Pacific coast of North America. They are so toothsome that it has been found necessary to protect them by law.

ing creatures to pass through and his siphons are drawn back into the cave in an instant if so much as a shadow falls upon them.

### A Worm That Wears a Bonnet

The "shipworm" that tunnels into wooden breakwaters, the piles of wooden piers, or any piece of submerged timber that happens to be handy, is very different in appearance from the little pholas. Of course it is not really a worm, although it looks like one; it is a true mollusk, and its proper name is the teredo (*tê-rê'dō*). This queer creature has a very long wormlike body with a tiny pair of shells perched on one end of it like an absurd little bonnet.

Of course a shell like this is of no use as a house; so the teredo is obliged to protect himself in other ways. This he does very thoroughly. In the first place he encases his long, soft body in a thin tube, in much the same way that the tube worms do. Then, to make this doubly secure, he tunnels his way into a thick piece of wood, hollowing out a long, dark gallery. There he lives, hidden out of sight, with only the tips of

his siphons protruding from the open doorway.

The teredo does not work with his foot as the pholas does; he uses his funny little double shell as a boring tool. Although so small it is very strong, and the front edges of the two valves are cut up into a number of sharp teeth. Each valve, too, is set on a separate little pivot on which it can be rocked as the teredo scrapes away with it, grinding the wood into fine sawdust. As he gradually works his way farther and farther into the wood, the curious animal clears the path before him by swallowing the sawdust as he goes along. Strange to say, this unusual food appears to agree with him very well.

### Worms That Will Gnaw a Ship

As shipworms may be anything from a few inches to over two and a half feet in length, you can imagine how much damage they are capable of doing. In olden days when ships were built of wood, teredos were a veritable pest. It was chiefly to meet the attacks of these troublesome mollusks that boats were sheathed with copper and the

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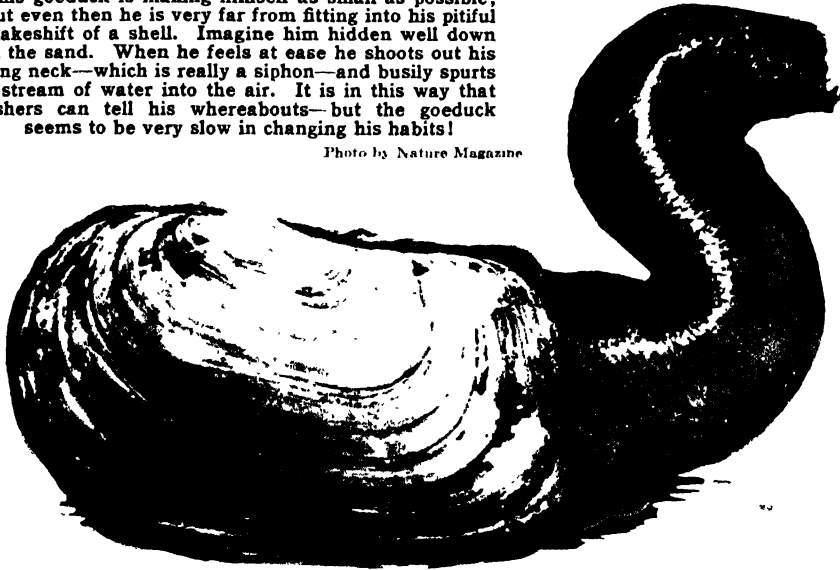
wooden posts supporting piers studded with broad-headed nails below high-water mark.

The date shells that scoop out snug little caves in corals or hard limestone rock, work on an entirely different plan. They have only a tiny foot and their shells are so thin and delicate that they cannot possibly be used as boring tools. But secreted in its mantle every little date shell has a supply

dull-looking things as a rule, though some living in tropical seas have beautifully colored green and brown shells. They spend most of their days in one place merely opening their mouths and sucking in the food carried to them by the water; but they can move if they want to. Now and then one will unfasten its beard from its anchorage, move off a little way, and fix itself to a fresh spot.

This goeduck is making himself as small as possible; but even then he is very far from fitting into his pitiful makeshift of a shell. Imagine him hidden well down in the sand. When he feels at ease he shoots out his long neck—which is really a siphon—and busily spurts a stream of water into the air. It is in this way that fishers can tell his whereabouts—but the goeduck seems to be very slow in changing his habits!

Photo by Nature Magazine



of strong acid stored in a special gland; with this the feeble mollusks actually hollow out their stony chambers by chemical action. The acid does not harm the shells of the little animals, for they are protected by a very thick, tough skin.

### The Sociable Mussel

The mussel, which is a cousin of the date shell, uses its tiny foot as a spinning machine. It spins a bundle of strong, coarse threads, called the beard, with which it anchors itself to stones, breakwaters, rocks—or sometimes even to its neighbors. For mussels are sociable creatures; they like to live in large family parties—big ones, little ones, and great-grandfather mussels all in a tangle together. Or they crowd in thousands in huge beds under the sea, all joined one to another by their beards. Mussels are rather

The scallops, or pectens, are much more interesting than the sluggish mussels. They live farther away from the shore than many bivalves do. If we could wander far out under the sea we might chance to come upon a scallop bed—a clear stretch of rough, gravelly ground with rocks and boulders scattered about.

Some of these handsome shell dwellers are lying here and there on the sea floor; others are clinging to the rocks; and some—yes, some are actually darting about, zigzagging through the water by flapping their shells just as if they were wings. It is the younger scallops who are enjoying themselves in this way. When they grow older they become more sedate and do not dash about so much. When they are very young and their shells are only just formed, the little scallops are rather timid and afraid to play about; so



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they spin a few threads with a wee foot, like a tiny white finger, and cling to the shelter of rock, stone, or seaweed. But they soon grow bolder, and casting themselves adrift, they start fluttering their valves, shooting backward through the water and enjoying themselves like their older brothers and sisters.

### A Row of Emerald Eyes

When a scallop is full grown its shell is often four inches or more across. It is a beautiful thing, like an open fan, gayly painted in varying tints of orange, crimson, or chestnut-brown on a white or pale straw-colored ground. The two valves of the shell are not exactly alike; one is like a saucer and the other is quite flat. The scallop lies in the deeper shell and the flat one closes down on it like the lid of a box, the scalloped edges of the two valves fitting into one another exactly.

When there is nothing to alarm it the scallop is fond of resting quietly on the ground with its shell half open. We are then able to get a glimpse of its plump orange or scarlet body through the folds of the mantle that stretches like a misty curtain between the gaping valves. The two edges of the mantle are bordered with a fringe of long, white, waving tentacles, and all along the margin is a row of shining green spots that sparkle and flash like emeralds. These are the eyes of the scallop. How much and how far it can see with them we cannot tell exactly, but they are certainly very sensitive to light, for if the slightest shadow is cast upon the shell the lid comes down in a hurry and the scallop is safely shut up in its box.

Scallops are sometimes called sea butterflies, but

this name is more often given to their cousins the lively limas (*li'má*), who flit about in the water in much the same way. They are pretty little creatures with pure white fluted shells hardly an inch long, either quite smooth or covered with prickly spines. The mollusk itself is gayly colored—bright yellow, crimson, or orange—and is wrapped up in a gorgeous mantle edged with a long scarlet fringe which trails out behind the little creature as it dashes about in the sea as if it were in a tremendous hurry and had not a moment to spare.

These sea butterflies are very nervous. When they are not flapping about, a number of them often cluster together for safety in a curious kind of nest made of sand, small stones, fragments of shell and coral, all bound together with sticky threads spun from their spinning machines. Viewed from outside this "nest" looks a hopeless jumble of odds and ends, but it is lined with quite a thick network of threads that it is quite cozy and comfortable inside.

### How Young Oysters Swim

Now oysters are much more sober in their ways; once they have settled down in an oyster bed they stay there. Their shells become so firmly cemented to the rock, stone, shell, or whatever they happen to be lying on, that they could not gad about even if they wanted to. But this is only after they have given up childish ways. Baby oysters, like most young things, are lively, restless little creatures. When first they make their escape from the tiny eggs broadcast by their mother into the sea, they swim merrily around, lashing the water with the fringe on the two little paddles with which they are provided, and having a thoroughly jolly time.



Photo by F. Martin Duncan

The scallop fringes his shell with bright-colored tentacles; and when he wants to move through the water, he shoots himself along by opening and closing the

two halves of his house. During the crusades the scallop's beautiful shell was worn by returning pilgrims as a sign that they had been to the Holy Land.

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Photo by American Museum of Natural History

Here is a salt-water pool close by the sea in April. All kinds of queer little beasts are busy finding their food. In the very front of the picture two soft clams

are shown at home at the bottom of their tubes; and at the right is a fiddler crab hidden away in his burrow, where he is relatively safe.

Baby oysters are at first so small you can hardly see them. They look like so many tiny specks bobbing about in the water. Small as they are, however, every little oyster has a transparent double shell and a pair of wee fringed flaps, like wings, to enable it to paddle about in the sea.

### A Mother of a Million Babies

At certain times of the year the water round about the oyster beds is literally packed with these lively little atoms. For oysters have very large families; one or two million babies at a time is quite an ordinary brood. American oysters get rid of their burden of eggs once for all, shooting them out into the sea to hatch or not as the case may be. But European oysters, as a rule, keep the eggs until they are hatched. They tuck them up in the folds of their mantles,

and the babies do not leave their parents' shells until their own tiny shells are formed. By this time the mother must begin to feel like the "old woman who lived in a shoe, who had so many children she didn't know what to do." So she opens her shell and turns the little oysterlings out of doors. They come streaming out in clouds, like little puffs of steam coming from the funnel of a steam engine.

Of course these baby oysters do not all live to grow up. They are swallowed in thousands by fishes, prawns, shrimps, lobsters, and all sorts of sea creatures, who think this kind of "oyster soup" very good indeed. Only a few are left to find a place in the oyster beds.

Even if they do escape all the dangers of the open sea the troubles of the baby oysters are by no means all over. If, when they

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Photo by American Museum of Natural History

This complicated device is really the humble oyster, which is a delicacy in many parts of the world. Oysters are very easily digested and are of great value for that reason. People liked to eat them way back in ancient times; and we know that in the first century A.D. the Romans re-stocked their beds with oysters sent down

from Great Britain, where the same beds are still bearing to-day. Oysters are the most valuable thing the fishing industry has to sell. You may often have heard it said that they should be eaten only in months that have an R in the name. This is true, for they spawn during the summer and should be protected.

## THE STORY OF THE SEA

sink down to the sea floor, they do not alight on something firm to which they can attach themselves, the poor little things run the risk of being smothered in the sand. For this reason in "oyster parks," where oysters are cultivated, the ground is strewn with broken shells, tiles, bundles of sticks, and all sorts of contrivances for the "spat," as baby oysters are called, to settle on. Great care is taken of oysters in the oyster parks. The water is kept clear, and every effort is made to keep their natural enemies, the starfish, the whelks, and other sea ogres, at bay. But I am afraid all this kind attention is very much like the "treat" given to the young oysters by the Walrus and the Carpenter when they took them for a walk along the sandy shore. You remember how that ended, don't you?

" 'O Oysters,' said the Carpenter,  
'You've had a pleasant run!  
Shall we be trotting home again?'  
But answer came there none—  
And this was scarcely odd, because  
They'd eaten every one."

And this is just what happens to the pampered oysters in the oyster parks. No sooner have they grown plump and fit for market than they are "eaten every one!"

### Few Pearls Are Found in Oysters

Pearls may now and then be found in oysters, but this does not happen often. The pearl oyster is not really an oyster at all; it is more closely related to the scallops and mussels and lives only in the warmer seas. But pearls are occasionally found in many kinds of shells with a pearly lining, including the mussels and the periwinkle.

There are a vast number of shells, some beautiful, some curious, all interesting in one way or another. There is the strange hammer oyster, who has a rough black shell shaped like the letter "T"; a thorny oyster, whose brightly colored red, purple, or yellow shells are covered with thorny spines; and the wing shells, with their shells expanded into two long narrow wings, one on each side of the hinge. Then there are the ark

shells—so like little Noah's Arks that one would expect to see them floating on the water instead of hiding in the sand as they do. The watering pot shells, found in the Indo-Pacific seas from the Red Sea to New Zealand, are long shells with one end expanded and perforated like the nose of a watering can. Lastly, there are the great clam shells, such as the giant clam, the largest of all bivalves, that lives in the blue lagoons and among the coral reefs of the East Indies. These are so huge and strong that if a man's foot or hand is caught between the two valves, the chances are he will not be able to release himself until the giant mollusk pleases to open its shell again. We might spend years travelling all over the world collecting shells and yet miss many kinds.

### What Is a Sea Hare?

We must leave the shell dwellers now and turn our attention to this funny little animal creeping over the seaweed-covered rock. What is it? It looks for all the world like a tiny model of a crouching hare, made by someone who was not very well acquainted with the animal. It has a small, blunt muzzle, two horns standing upright on the top of its head like a pair of long ears, and appears to be clothed in a dark, tight-fitting velvet coat speckled all over with white dots.

This strange little beastie is called a "sea hare," but it is really a mollusk. Although it is certainly not a shell dweller, it does possess a shell, about the size and shape of a small teaspoon. This is hidden from view, for the sea hare carries it on his back and covers it with his mantle, which has two side flaps that are folded over it.

### Do Not Stroke a Sea Hare

It is just as well not to touch the little creature, although he is perfectly harmless. If startled he has an unpleasant habit of squirting a purple fluid from his mantle that stains everything it falls on. Most sea hares live in fairly deep water, though they often visit the pools and shallows near the shore. They can crawl over the rocks, swim, or creep upside down upon the surface of the water, just as a pond snail does.

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# *The STORY of LIFE in the SEA*

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## Reading Unit No. 10

### WHERE OUR PEARLS COME FROM

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How a pearl is formed, 3-162  
Pearls "of the first water," 3-163  
Where the best pearl fishing is done, 3-163  
How pearls are brought up from

the sea, 3-163  
Fresh-water pearls, 3-163  
How we force the oyster to make a pearl, 3-163-64  
Artificial pearls, 3-164

#### *Things to Think About*

What relation is there between pearls and sand?  
Why do pearls vary so much in price?  
What risks do pearl divers face?

How are "culture pearls" made?  
How are herring used in making artificial pearls?  
Why should people who own pearls wear them often?

#### *Picture Hunt*

How have pearls been regarded by royalty? 3-162  
Why is pearl diving dangerous?

3-163  
Where does a pearl diver work? 3-164

#### *Related Material*

What is a mussel? 3-260-62  
Why do whole families hunt for clams along the Mississippi

River in the summer? 3-262  
In what shellfish are most pearls found? 3-160

#### *Leisure-time Activities*

PROJECT NO. 1: Visit a factory which makes artificial pearls, or study their exhibits.  
PROJECT NO. 2: Hunt for

pearls in fresh-water mussels on the banks of a stream. One often finds a tiny seed pearl.

#### *Summary Statement*

Pearls are built around a grain of sand that irritates the soft mantle of the pearl oyster. They

are so precious that some people risk their lives to obtain them.



Photo by Metro-Goldwyn-Mayer

A vision of gleaming pearls lying in the smooth curve of an oyster shell may very well rise before the mind of the Malay pearl diver as he comes to shore with his basket of oysters. But he himself will never wear the pearls. Being "of great price," they will go to the rich and great of the world, as has happened from the

beginning of history. The Mogul emperor on his throne wore an enormous rope of pearls. Cleopatra dissolved a pearl in her wine to show Antony how lavishly she could entertain him at dinner. Caesar is said to have conquered Britain largely in the hope of finding pearls. The court robes of Queen Elizabeth were stiff with them.

### WHERE OUR PEARLS COME FROM

*In the Folds of the Ugly Oyster We Find Our Pearls of Greatest Price, and We Can Help the Oyster to Make Them, Too*

**I**N ALL the treasures of the deep there is none lovelier or costlier than the one that comes out of the lowly oyster. It is the pearl. As far back as history goes, the pearl has been a prize to hunt for in the waters, and in olden days there were various quaint notions as to how it grew inside the oyster. Some of the people thought it was made by a flash of lightning striking on the oyster shell, and others believed that if a drop of dew fell in the shell it would be changed to a pearl.

Of course we know better now. A pearl is born when some tiny thing creeps into the oyster's shell and irritates the animal. The thing may be a little worm, a grain of sand, or some other gritty substance. When it gets between the shell and the soft mantle of the mollusk, the oyster may protect itself

by covering the intruder with the same pearly substance that lines its shell. This substance is called "nacre" (nā'kēr), or "mother-of-pearl." It is put on layer upon layer, and in the end it makes a pearl.

The pearl oyster is not the kind of oyster we eat. It is not really an oyster at all, but is more like a mussel or a scallop. To be sure, any shellfish that lives in a shell with a pearly lining may produce a pearl, though only very rarely; and even with the pearl oysters, only one in a thousand is likely to produce a pearl of any value. Yet the large and shapely pearls are such prizes that it is worth the toil of hunting and opening thousands of oysters to find a single one.

Few of them are large, and few of perfect shape. If they grow on the lining of the shell itself, they will be flat on one side, and

## THE STORY OF THE SEA

then they are called "button pearls." If they are fastened to the shell by a narrow neck, they are called "blister pearls." And if they are very small, growing usually in the muscles of the oyster, they are called seed pearls. But when they grow large and round in the tissues of the animals, and have a fine soft luster without any flaw, they are the rare pearls "of the first water" that are worth a little fortune.

Men have fished for pearls since very ancient times, around India and the Persian Gulf, and they are now fishing for them in many parts of the world—in India, Japan, and China, in Australia and around many a Pacific island, in the Gulf of California and the Gulf of Mexico, and in still other places. There is commonly one fishing season every year, usually in the spring; for it would not do to keep fishing all the time—there would soon be no pearls left to wear in ring or brooch or necklace.

### Working on the Ocean's Floor

The fishers are all divers. They go down from a boat, and walk around on the floor of the ocean, gathering the shells they find and putting them in baskets. In many parts of the world they wear diving suits, and can stay down a long while. But in the Far East the Japanese and Malay divers often go into the water just as they are, with a big stone to carry them down; and even if they do not meet a shark, they cannot stay below

much longer than a minute. It is a dangerous trade, and shows the risk that men will take for gems.

### The Search for Pearls

Sometimes the shells are opened right on the boat, but usually they are taken to the shore and spread out for some days to decay. Then they are washed and carefully searched, and any pearls that may be found are taken out by hand or with special tools.

In addition to the pearls that come out of the sea, there are a good many from the streams and rivers. These are called "fresh-water pearls." They are found in many places in Europe and America, and all through the Temperate Zone. They have less luster than the ocean pearls, and are by no means so valuable; though the best of the fresh-water pearls are still very beautiful



Photo by American Museum of Natural History

If we could watch what happens both on the water and under it, we should see something like this when the brown men dive for pearls. It makes one catch one's breath in suspense, hoping that the man on the bottom will be quick enough to escape the shark!

and may bring high prices.

Now if a grain of sand that strays into an oyster can start a pearl, why can we not put a grain into the oyster and force him to make a pearl? We can, perfectly well; and men have been doing it, especially in China, for many a century. What they do is to cut a tiny piece out of the mantle of one oyster, wrap it around a bit of mother-of-pearl or of some other substance, and then plant it in the mantle of another oyster. And the second oyster duly proceeds to build a pearl around it. These oysters are

## THE STORY OF THE SEA



Photo by Metro-Goldwyn-Mayer Co.

This photograph of a pearl diver at his dangerous work was taken from a diving bell somewhere in the South

Seas. Amid bright coral and startled, mysterious fishes, he plies his difficult trade.

carefully fed and protected, in special beds or cages, and in time are opened for the pearls they ought to bear. The surgical operation does not always succeed—by no means; but when it does, there may be a fine pearl. Such a pearl is not artificial, for it has been made by the oyster. But because we helped in the process, we call it a “culture pearl.” Sometimes the Orientals coat little images of their gods with pearls in this way.

### What Is an Artificial Pearl?

The artificial pearls are very different. We make them by simply coating a glass bead with a substance known as “pearl essence,” which we get from the silvery scales on the under side of certain little fishes—like the sardine, the herring, and the fresh-water “ablette,” found on the continent of Europe. We mix the pearl essence with celluloid, and

put on several coats. Although these pearls may be made cheaply, they are often very beautiful, and it is hard to tell them from the real ones. Sometimes we use a hollow glass bead, coating it on the inside with pearl essence and gelatine, and then filling it with wax. But it does not look so “real.”

There are some pink pearls, and yellow pearls, in addition to the creamy-white ones that are commonest; and there are black pearls that are very highly prized. A pearl needs only a little polishing to make it ready to wear, for of course it is never cut like a diamond or any other precious stone. But the owner of a pearl has to be careful with it. He must never put it in hot water, or he will ruin its sheen, and he must not leave it in the dark long, or it will lose its luster. It needs to have an airing fairly often. People who have pearls must wear them.



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# *The STORY of LIFE in the SEA*

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## Reading Unit

### No. 11

## OGRES OF THE SEA

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

### *Interesting Facts Explained*

How the octopus hunts its food, 3-167

How the arm of an octopus is fitted for its job, 3-167

Enemies of the octopus, 3-168-69

The smoke screen of an octopus, 3-169

How the mother octopus takes care of her eggs, 3-169

Squids and argonauts, 3-169-71

### *Things to Think About*

What enables an octopus to cling to rocks so tightly?

Why are squids considered dangerous?

What important substance do artists get from cuttlefish?

Why are squids and cuttlefish called mollusks?

Are the octopus and squid really dangerous to man?

What cousin of the octopus builds a beautiful shell?

### *Picture Hunt*

Why did men once believe what is shown here? 3-166

What does an octopus eat? 3-167

What part of a bivalve mollusk can be compared with the umbrella and tentacles of an octopus? 3-168

Where do we obtain the "bone" that canaries use in their cages? 3-170

Why has man feared the deep-sea squids? 3-171

What enables sperm whales to catch and eat squids? 3-172

### *Leisure-time Activities*

**PROJECT NO. 1:** Visit a local sea-food market for squids and octopi. Take one of each home for study. See if you can dissect

out the ink sac in each. By opening the stomach you may discover what food had been eaten by the animals.

### *Summary Statement*

The sea seems peaceful on the surface, but a fierce struggle for existence goes on below. The octopus with its eight snaky, vacuum-cupped tentacles is a real menace to fish. When an octopus

is attacked, it squirts out an inky fluid which acts as a smoke screen while it escapes. The squid may reach a length of sixty feet and is as voracious as an octopus.

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From an Old Print

This gruesome thing never happened anywhere in the world. But men used to think it might, and probably

lay awake worrying about it. It makes us wonder how many of our fears to-day are just as silly!

### OGRES of the SEA

#### *The Terrible Octopus Once Haunted the Dreams of Sailors, and He Still Is the Terror of Many a Deep Sea Cave*

HE ogre is at home. He is resting in his cave under the sea. It is a charming little cave, hollowed out in a coral rock with a soft curtain of palegreen weed half hiding the entrance and the monster lurking within. We can not see much of him, for it is almost dark at the back of the cave where the ogre is crouching, but from the gloom two pale, cold, wicked eyes stare unblinkingly out into the water.

Outside all looks peaceful. Paths strewn with silvery sand and pearly shells wind away into the dim blue distance between banks of coral, all pink and white and violet with the starry heads of thousands of polyps. Giant boulders are incrustated with the soft, velvety weed that many little sea folk like to nibble. Graceful sea fans and sea firs bend and sway in the quiet surge of the water; many-hued anemones expand their flowery heads on the rocky ledges; and col-

onies of tube worms wave their feathery crowns from the tops of their chimney-pot houses.

Wee blue crabs scuttle over the sand, gayly colored shrimps and prawns whisk about, and funny little fishes, looking ridiculously like gnomes and goblins, play hide and seek in and out of the nooks and crannies of the rocks. There seems nothing to fear in this garden of the sea; anyone would imagine that it was the safest playground in the world for the little sea people. But we have seen those cruel eyes peering out from the cave.

Round the bend of a big rock comes a school of slender fishes, gleaming silver and blue as they move easily through the water. They keep together in close formation except when they break their ranks to dart and snap at a swarm of tiny wriggling things that catch their bright eyes. Now one of

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the fishes, lagging a little behind the others, makes a sudden dash at a scarlet shrimp. Ah! he has missed it. With a flick of his tail he turns to follow his companions. His way lies past that little cave. A long snaky arm is shot out. It coils like a whip lash round the slender, gleaming body, and in a moment the struggling fish is dragged inside the ogre's den!

All is still and quiet again. The wander-

seems to flow over the angles and edges as if he were more than half fluid. But he is solid enough in reality; make no mistake about that. Each of the long, tapering arms is clothed with about a hundred and twenty pairs of suckers. At the tip of the arm they are tiny, buttonlike things, but they gradually increase in size as the arm thickens, until at the base they may be two inches or more in diameter. These suckers are perfect



Photo by N. Y. Zoological Society

This is the way the octopus hunts at home. If the creature is a giant, those snaky arms can reach out five feet and grab his luckless prey. Without noise or

stir, his meal is all over in an instant—and then he is ready for the next one. Meanwhile the careless fish float by like swarms of dainty butterflies.

ing fishes have gone on their way. They did not even notice that one of their number was missing. Presently the seaweed curtain is pushed aside, and the ogre, now rested and refreshed, comes forth from his lair. Oh, dear! how ugly he is! Slowly he emerges from his retreat. First a circle of writhing arms appears, then a great ugly head joined by a short thick neck to a wriggling, baglike body. Now that he is out in the open we see that the ogre is an octopus (øk'tô-pŭs), one of the most fearsome and hideous tyrants of the deep sea.

He slithers down on the rocks and begins creeping over them in a horrible way. He

vacuum cups. Each one has a raised rim surrounding a hollow cavity, with a fleshy piston at the bottom of it worked by powerful muscles. So tightly do they cling to everything they fasten on that it is easier to tear the whole arm from the octopus than to make him release his hold.

### An Eight-armed Monster

The octopus has eight of these appalling arms, arranged in a circle round his mouth and joined together at their base by a strong, thin web. When stretched out wide they form a kind of parachute around the creature's head. In the center of the circle is a

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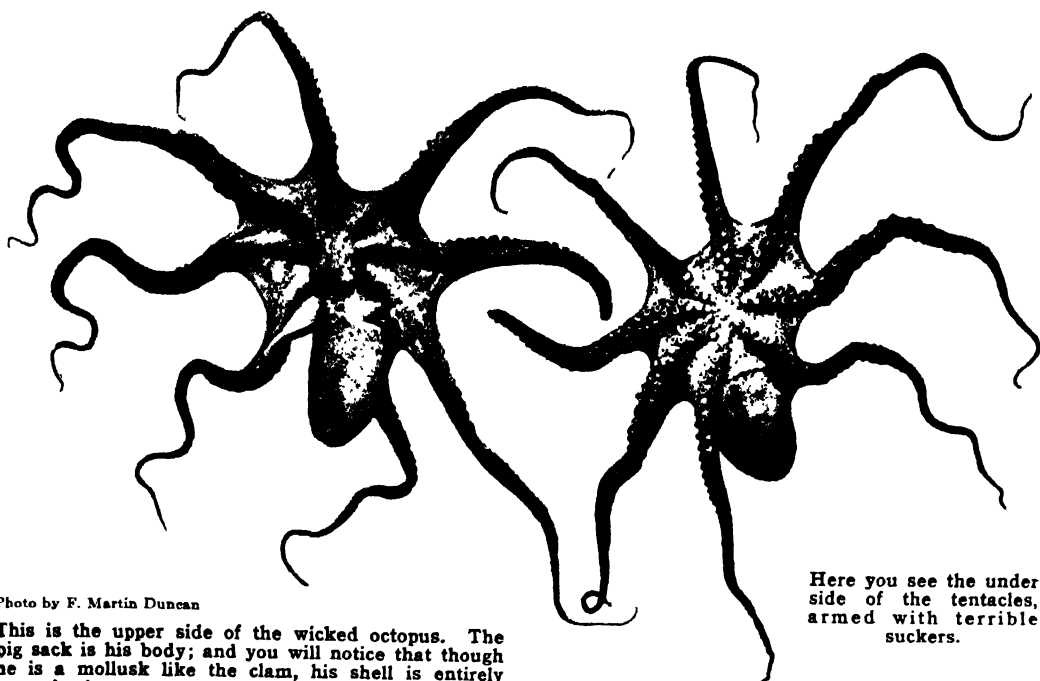


Photo by F. Martin Duncan

This is the upper side of the wicked octopus. The big sack is his body; and you will notice that though he is a mollusk like the clam, his shell is entirely gone, for he can protect himself with his terrible tentacles. The "umbrella" around the head is made out of his "foot," which in other mollusks is drawn inside the shell. The flesh from the "arms" of young and medium-sized octopods is said to be delicious when served hot, and brings a good price in Naples, where it is sold.

Here you see the under side of the tentacles, armed with terrible suckers.

round, thick-lipped mouth armed with a strong, horny beak, like the beak of a parrot. Inside the mouth is a horrible tongue, covered with sharp recurved spines, and a bag of poison with which the dreadful ogre paralyzes his victims when he has bitten them with his beak. No wonder the octopus is hated by all the dwellers in the sea.

But this is not all. Projecting under his head is a curious, funnel-shaped tube called a "siphon" (sī'fōn), and back of this arrangement, hiding under a flap of skin, is an "ink bag." To what use the octopus puts these strange contrivances we shall see presently.

### The Ogre in His Lair

After slipping and sliding on the rocks for a time the ogre rises in the water and paddles slowly forward by opening and shutting his parachute and waving his snaky arms. Then, deciding that there is nothing to interest him here, he suddenly squirts a jet of water with great force from his funnel; this sends him shooting backwards at a terrific speed. In

a moment he is lost to sight. We wonder how many sea folk he will devour or frighten out of their wits before he slinks, like some dark, evil shadow, back to his lair.

Unless something occurs to upset his regular habits, the octopus spends the bright hours of the day alone, skulking in the shadow at the back of his cave. His staring eyes are fixed upon the doorway, watching all that goes on outside, and his long arms are always ready to seize any unfortunate creature that comes within his reach. The threshold of his den is strewn with the shells and bones of his victims. So he passes the time away until evening falls, when, like some fearsome dragon of old, he steals silently from his hiding place and sets out in search of prey.

So fierce and bold is the octopus that there is hardly any sea creature he will not attack. But now and then this bully meets his match. Whales will devour him, beak, suckers, and all, if they chance to meet him out on a hunting expedition; and sharks, dogfish, and giant conger eels are ready to fight him and make a meal of him if they can. Terrific battles sometimes take place between these monsters. The octopus flings his arms round his opponent, and clinging to him with all

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his suckers tries to drag him by main force towards his terrible beak. The huge fish meanwhile tears at him with its teeth and thrashes about with its tail until the sea is churned into foam by their violent struggles and all the terrified sea folk who happen to be near flee in dismay from the commotion.

If he finds he is getting the worst of the encounter the octopus often effects his escape by a clever stratagem. He suddenly releases his grip and shoots the contents of his ink bag full in the enemy's face. The inky fluid

spreads like a cloud in the water. Before the astonished and blinded creature recovers from the shock the wily octopus has beat a hasty retreat, darting rapidly away, stern foremost, under cover of the "smoke screen" he has created.

He does not always escape scot-free; but if in the struggle he has lost an arm or two, this causes the octopus only temporary inconvenience. He may stay at home sulking in his den for a while, but before very long new arms, complete with their horrid suckers, will have replaced the old ones.

The female octopus is quite as savage and bloodthirsty as her mate, but there is one thing to be said in her favor; she is a devoted mother and takes the greatest care of her very large family. Choosing as her nursery a quiet, secluded spot at the bottom of the sea, she carefully fastens forty or fifty bunches of eggs under a shelving rock; and there she stays through fifty long days and nights until the young ones are hatched. The eggs look like bunches of grapes; and since each bunch contains eight or nine hundred eggs, a female octopus has plenty to do looking after them all. But she is untiring in her devotion. She clasps each bunch in her arms in turn, sprays it with water from her funnel to keep the eggs clean and well supplied with air, and hardly leaves her nur-

sery for a moment except to make a sudden dash for a passing fish or lobster to satisfy her hunger.

Her temper at this time is really shocking. She suspects every creature in the sea of a desire to steal her precious eggs. Even the father dare not venture too near. If he shows his ugly face in the nursery, the mother shimmers with rage, waves of changing color ripple all over her, she glares at him in a fury, threatens him with her arms, and if he does not take the hint and take himself off with all possible speed, she rudely squirts a stream of ink over him!

An octopus changes color in a most extraordinary way when it is excited by anger or even by the sight of something good to eat. When resting, too, it is able to hide itself from its foes and victims by turning almost exactly the color of the rocks or whatever it happens to be crouching on. When at last the cares of the female octopus are over and the eggs hatch, the young ones leave their dim nursery down at the bottom of the sea and rise at once to the surface to sport

about in the warm sun-lit water. Here, with only a few exceptions, they are promptly gobbled up by the fishes. And a good thing it is, too; for if all the millions of baby octopods (ök'tō-pöd) lived to grow up, there would be no peace or safety for any of the sea people except whales and sharks and like monsters. Among those which might give battle are the octopus's own first cousins, the giant squids, which are every bit as fierce and cruel as the octopus

### Ferocious Squids and Cuttles

While the octopus lives like a wicked old dragon in a cave or cranny in the deeper offshore waters and seldom ventures out until the evening, the squids and cuttlefishes lead a roving life, hunting their prey with frenzied



Photo by N. Y. Zoological Society

Here is one of the few deep-sea creatures that is not afraid of the octopus. It is the terrible shark, which has respect for neither man nor fish

## THE STORY OF THE SEA



Photo by F. Martin Duncan

This ungainly cuttlefish has had the bad luck to be stranded. But that was fortunate for us, since it gives us a chance to see his curious lumpy body and long tentacles. All that is left of his mollusk shell he

carries inside his body. And when we catch him, we take it out and put small pieces of it into canary birds' cages, for our pets to nibble at. It seems a strange fate for the great creature.

ferocity all over the open seas. Large shoals of the smaller squids and cuttles often appear near the coasts, where they dash about pursuing and devouring fishes quite as big as themselves. But the giant squids keep far out in the great depths of the ocean; where their huge size and ruthless ways fill every sea creature that encounters them with horror and dismay.

### The Tinted Demon of the Deep

Squids vary in size from tiny things only a couple of inches long to appalling monsters measuring sixty feet or more, but from the largest down to the smallest they are all most determined and relentless hunters of prey. They do an immense amount of damage to the fishing industries; large numbers of herrings are destroyed by them year after year on the Scottish coasts, and the mackerel fisheries on the American coast are sometimes quite spoiled by ravaging hordes of these troublesome sea rovers. They seem to kill for sport as much as for hunger, for they will bite one fish after another in the back of the neck, pursuing the poor frightened things with mad ferocity and leaping quite

out of the water in the excitement of the chase. As they dash wildly here and there, the squids constantly change color in a bewildering way. They flush from white to pink and from pink to scarlet, next turning rose, salmon, cream, then white again so rapidly that each one appears to be four or five different animals!

Like the octopus the squid has a circle of sucker-clad arms round its mouth. They are much shorter in proportion to the size of the animal, but to make up for this it has two extra arms that are sometimes three times its own length. They are bare except at the tip, which swells out like a club and is covered with horrible suckers. These have hard, horny rims cut, in some cases, into cruel hooked teeth that claw and tear the prey they fasten on.

### Ink from a Cuttlefish

The squid's body is rather like a torpedo in shape, with a triangular fin along the rear end. The cuttlefish is more stumpy, but otherwise the two creatures are much alike both in looks and manners. Both have pale, glaring eyes that make one shudder and an

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ink bag from which they eject a cloud of inky fluid in order to baffle their enemies when they wish to make good their escape. When not engaged in actively chasing their prey, they are fond of anchoring themselves with their shorter arms to floating seaweed or timber while they fish for prey with two long arms. The true cuttles, which are seldom more than eighteen inches long, like to lie half buried in the sand and dart out upon the crabs, lobsters, and fishes that pass by. The common cuttlefish is called the Sepia (sĕ'pĭ-ă). From the contents of its ink bag the best artist's sepia is manufactured. Now strange as it may seem, these terrible sea

is rarely more than two inches long. It loves to bury itself quite up to its goggling eyes in the soft sand, where it keeps a sharp lookout for prawns, shrimps, and tiny crabs.

In olden days the octopus and the giant squid were called the "devilfish" and the "kraken" (krä'kĕn); and many were the thrilling tales told by travellers of desperate encounters with these fearful sea monsters. They were said to clasp great ships in their arms and drag them down to the bottom of the sea. Of course these tales were mostly travelers' yarns; no "devilfish" or "kraken" could do such things as that, although some of the creatures are powerful enough to seize

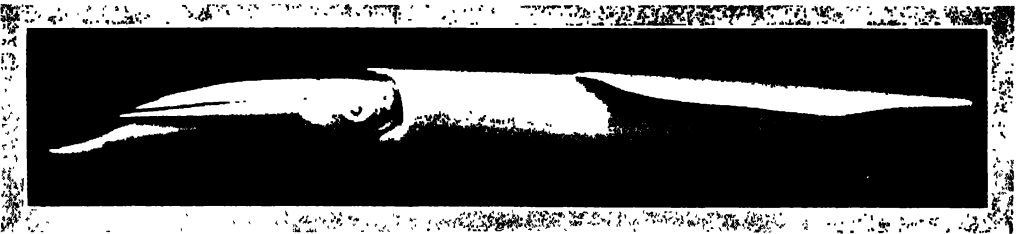


Photo by American Museum of Natural History

The common squid is not quite so solid a creature as the picture would suggest, for this is only a model. But you can see his bulging eye and curious long

"arms," here all folded together. Some giant squids grow as long as sixty feet. Darting about in the water, they must look like some queer kind of submarine.

ogres belong to the same division of the animal kingdom as the pretty little top shells, the beautiful painted scallops, and the land snails. They are in fact mollusks. But because of the curious arrangement of their feet—or arms, as they are usually called—they have been named "Cephalopods" (sĕf-ă-lō-pōd), from two Greek words that mean "head-footed."

### What Is a Devilfish?

The squid and the cuttlefish actually have shells, though as they are worn inside instead of outside the mantle they are not visible. The squid's long, narrow shell is very thin and transparent and is called a "pen" because it has some resemblance to the old-fashioned quill pen our grandfathers used to write with. The cuttle's shell is hard and limy and much broader. It is often cast up on the shore from the sea and is commonly called a "cuttle bone."

The queer little "Atlantic squid" is really a dwarf cuttlefish. Its plump, squat body

a man and drown him if he should be so unfortunate as to meet one when he is swimming in the sea. A very large octopus is about the size of a football, with arms four or five feet long—which is quite big enough. But you do not often meet with one so large as this. Some varieties are no bigger than a small coconut, with arms in proportion. A giant squid with tentacles thirty feet long might certainly upset a small boat if he clasped it with his suckers; but on the whole these sea monsters are much more dangerous to sea folk than to human beings.

### Battle of the Giants

The chief enemies of the deep-sea squids are the sperm whales, who hunt them and devour them, seizing them with their great, crushing teeth. Sometimes a right royal battle takes place between two of the ocean giants. While the whale and the gigantic squid are locked in deadly conflict, lashing the sea to foam in their titanic struggle,

## THE STORY OF THE SEA



Photo by Union of South America

Here are two sperm whales, chief enemy of the deep-sea squids. These giants grow to a length of forty or fifty feet, and heave their great bulk through all the

dozens of sharks hover round, ready to rush in and share the feast when the combat is over and the victor proceeds to demolish his conquered foe.

The octopus has no shell, or only the vestiges of one in the shape of two little plates concealed within the folds of its mantle. But its tiny cousin, the "argonaut" (är'gô-nôt), or the "paper nautilus" (nô'tî-lûs), has one of the most beautiful shells in the world. The little creature itself is not prepossessing; it is like a diminutive octopus with arms only a few inches long. But the silvery white, fluted shell is an exquisite thing, quite unlike the shells of other mollusks.

Only the female argonaut possesses a shell. She makes it herself with the aid of the shell glands in two of her arms, which are much

tropical and subtropical seas. Unlike a good many whales they have teeth—on the lower jaw only—and so are able to vanquish the squid and the cuttlefish.

broader than the others. It is really more a cradle than a house. For the mother uses it chiefly as a shelter for her eggs, although she sits inside it, clasping it firmly with her broad arms. But she is not herself attached to the shell in any way. She could leave it if she wished, just as a hermit crab could leave the shell he has chosen as his home.

At one time people imagined that the argonaut was in the habit of floating over the surface of the sea, its two broad arms held aloft to act as sails. This was a very pretty notion, but unfortunately it was not true. The argonaut crawls about on the floor with its shell on its back, like any common garden snail. When it does rise to the surface it is usually in stormy weather. Then it swims along backward by ejecting water from its funnel, as big octopods do.



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# ***The STORY of LIFE in the SEA***

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## **Reading Unit**

### **No. 12**

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## **CRUSTY FOLK ALONG THE SHORE**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

### ***Interesting Facts Explained***

The first animals with legs, 3-175  
The armored shells of crabs, 3-175-76  
How crabs breathe and eat, 3-176-77  
The strange life of a baby crab,

3-177-78  
How crabs hide from their enemies, 3-180-82  
Why the hermit crab needs a mollusk shell, 3-182

### ***Things to Think About***

How is a crab fitted for living in the sea?  
How are crabs often useful to us?  
Why must young crabs shed their skins frequently?

What are some of the ways in which crabs hide themselves from enemies?  
How does the hermit crab get its shell?

### ***Picture Hunt***

Why is it hard to recognize baby crabs? 3-177  
What crab burrows into sand? 3-179  
Why are some kinds of crabs very hard to find? 3-180  
How did the "robber crab" get

its reputation and name? 3-181  
How do some crabs protect themselves? 3-182  
Why must a hermit crab live in a shell? 3-182

### ***Related Material***

What crustaceans are cousins of the crab? 3-185-92

In what way is the lobster like a crab? 3-186-89

### ***Leisure-time Activities***

PROJECT NO. 1: Buy a live blue crab at the fish market. Study its shell, its different kinds of legs, and the way it sends water back over its gills, 3-175  
PROJECT NO. 2: Make an ex-

cursion to a beach at low tide. Notice the way fiddler crabs burrow into the wet sand, and how they move. Try to find other kinds of crabs near the water, 3-182

### ***Summary Statement***

Crabs are armored, ten-footed sea creatures. They grow by shedding their hard shells. Some crabs burrow holes into sand;

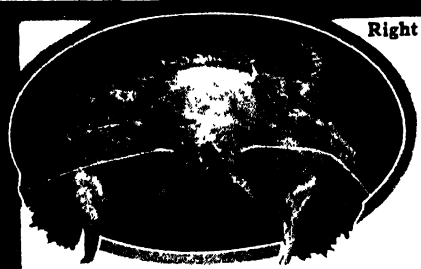
some retreat into abandoned shells; some cover themselves with sponges, anemones, and even seaweed; some have sharp spines.

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Right: Hermit crab without a home.

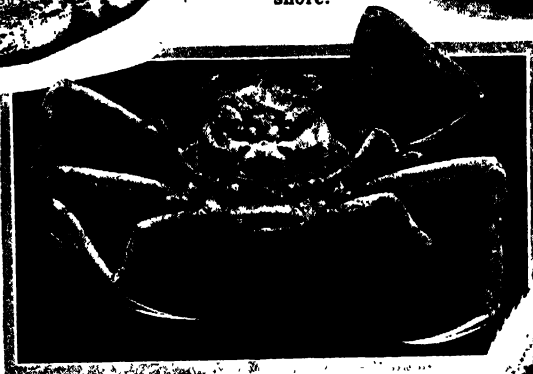


In the upper left-hand corner is the broad-clawed porcelain crab that likes to hide away under flat rocks near the low-tide mark along the shore.



The clownish little crab above lives in Panama.

Above is the under view of the ingenious Dromia, or sleeping crab. He plants a living sponge on his back to hide him from his foes, and at last he is completely covered under its spreading bulk, as is shown in the picture.

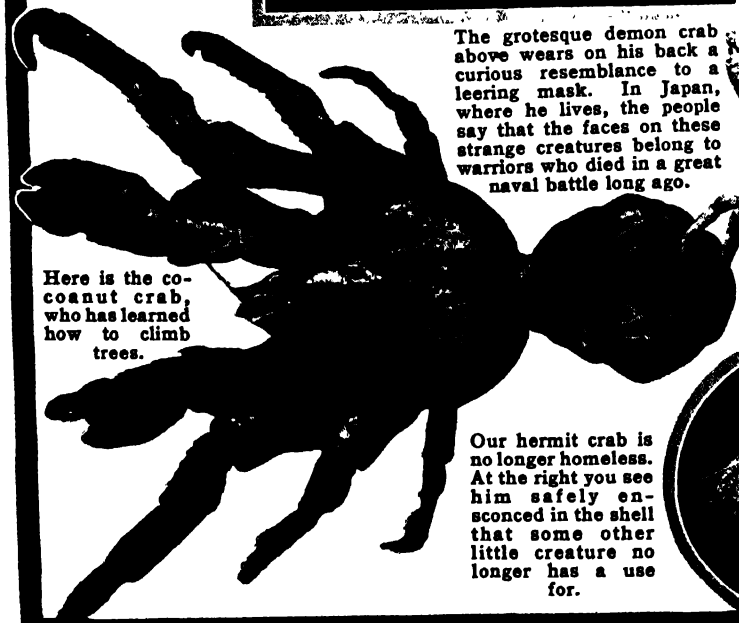


The sturdy Galatea crab below is also called the squat lobster. He is common around the British coasts.



The grotesque demon crab above wears on his back a curious resemblance to a leering mask. In Japan, where he lives, the people say that the faces on these strange creatures belong to warriors who died in a great naval battle long ago.

Here is the coconut crab, who has learned how to climb trees.



Our hermit crab is no longer homeless. At the right you see him safely ensconced in the shell that some other little creature no longer has a use for.



Photos by F. Martin Duncan and American Museum of Natural History

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## THE STORY OF THE SEA

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Photo by N. Y. Zoological Society

One wonders if the acrobatic fellow above is doing his daily dozen. It is hard to think he could stay long in that uncomfortable posture. But if you had as many

legs as this blue, or edible, crab, you might be able to do all sorts of interesting things. His life is not all fun, however; for he is the crab we eat at table.

### CRUSTY FOLK ALONG *the* SHORE

*The Crab Is as Crabbed as His Name, and Will Give You a Sharp Nip Whenever He Gets a Chance*

**I** WONDER if you have noticed that among all the various creatures we have so far met in the sea world not a single one has had any legs. Most of them have had feet of some kind—false feet, bristle feet, or tube feet. Some have had only one foot, which the odd little owner could creep or hop about on, or use in some curious and unusual way. But of real “honest-to-goodness” legs we have not seen one.

Of course sea folk are not all in this legless condition. A crab has legs, ten of them, though only eight are used for walking. The first pair with the great claws serve more as arms than legs. A crab is in every way a much more highly developed and much more intelligent animal than any of the other

creatures whose acquaintance we have made up to the present. It is wonderfully protected and equipped, in order that it may hold its own in the struggle for life that is always going on in the sea.

On his back the crab carries a hard, horny shield, so large that he can hide himself entirely underneath it. In front he wears a breastplate, and even his ten legs are all incased in armor. The shield is called the “carapace” (kār’ā-pās). Although it appears to be formed of a single piece it is really made up of several sections welded firmly together. The front edge of the shield is notched or scalloped, and from beneath it the crab’s twinkling, beady eyes pop in and out on their little eyestalks in a most comi-

## THE STORY OF THE SEA



This stirring battle scene shows a sharp encounter between several pairs of greedy crabs. The prize will

be the delicious dead fish over which they are swarming, and each one seems loath to share the dainty.

cal manner. His eyes and his feelers and his jaws are all that can be seen of the gentleman's head. He has two pairs of feelers, or antennae (ăn-tě'n'c), one pair much larger than the other. His mouth is a wonderful arrangement made up of a great many different parts for feeling, crushing, and biting his food; and in addition to all these utensils, he has three pairs of "jaw feet," just under his mouth, that look like three small extra pairs of legs.

### How a Crab Breathes

The four pairs of walking legs end in simple spines, while the first pair, which is broader and stronger than the others, bears the great nipping claws that the crab uses for fighting as well as for seizing and crushing his food. With such a splendid suit of armor and such an array of claws, jaws, and jaw feet, our friend is very well able to take care of himself and defy his lesser enemies, at least, both on the shore and in the sea.

Many crabs spend a good deal of time out of the water, running about on the shore or hiding among seaweed-covered rocks. Yet they breathe just as other sea creatures do, by extracting oxygen from the salt water with their gills. When on land they are able to retain a small quantity of water in their gill chambers, which are situated behind the head, one on each side, under the broad back shield. So long as their gills

are kept moist the crabs are quite happy and comfortable.

To see a number of crabs scuttling about over the sands when the tide is out, engaged in their chief occupation in life, which is hunting for something to eat, is one of the funniest of sights. They are able garbage collectors, and quickly scent out any dead fish that has been cast up on the shore. Too cautious to make a bee line for the fish, they approach it by a series of short, side-long darts. First they run a little way towards it, then pause to look around and brandish their claws in one another's faces, then run on again. At last, with a final bold dash, they seize the fish and try to drag it into the water, so that they may enjoy the feast undisturbed. If the fish is too big to be moved, the crabs set to work to devour it then and there, fighting and quarreling over the food in the most unseemly way. If too many of them have assembled at the banquet, those who cannot secure a good place at table bubble with rage. A general scrimmage takes place, in which the small crabs are often set upon and devoured by their stronger brethren. But if one old crab finds something good to eat all by himself and no friend or foe comes to dispute his claim to the prize, he settles down to enjoy himself with calm deliberation. With an air of much solemnity, he picks his meat to pieces with his claws and

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stuffs it into his mouth, his beady eyes rolling in ecstasy the while. If left undisturbed he eats away steadily and methodically until not a morsel is left.

### Some Crabs Play 'Possum

Crabs have a good deal of character, and do not all behave in exactly the same way. Some if startled will "play 'possum," lying quite still with their legs stretched out limply as if they were dead; others scuttle away as fast as their eight legs will carry them.

a loose, transparent skin, so that it appears to be carefully wrapped up in a soft, fine shawl—which of course is quite the correct thing for small babies. But these water babies do not like being wrapped up in this fashion. Almost at once they begin to jerk about and kick and struggle until they wriggle themselves free from their swaddling clothes. Then up they go to the top of the water and start gamboling and frisking about as if they were highly delighted to find themselves at liberty in the great sea world.



Photos by F. Martin Duncan

Here is one of the crab's curious children, at different stages in its career. The picture at the left shows him at birth, before he kicked himself free of his swaddling clothes. At that time he is not much larger than a pinhead. Next he grows all the curious horns

and legs that you see in the second picture. And then, as shown in the two views at the right, he reaches the last stage before emerging as a real crab. He has a right to feel quite grown up now, though really he is no larger than a capital O.

Some take cover under rocks or seaweed, or dig themselves hastily into the sand; but the bolder ones rear up on their hind legs, snap their claws, shoot out their eyes, and foam with rage. As a nip from the big pincers of an angry crab is no laughing matter, it is just as well to take the hint and not interfere with the gentleman.

### How Crabs Multiply

A baby crab is not in the least like its parents. The mother carries her eggs about with her tucked away under the short triangular tail that she keeps turned up underneath her body. But when they are hatched she loses all interest in her offspring and wanders off, leaving her babies rolling helplessly about on the sea floor. They are tiny things, no bigger than a small "o" on this page. Each one is completely enveloped in

But what strange little objects they are! They have great round heads, two large round eyes, long feathery legs, and long forked tails. On the back of every little head is a long spike, and from the front of the head another spike sticks out like a very long nose. Anything less like a crab you can hardly imagine!

These quaint water babies are called "zoëas" (zô-ě-ä). They swim gayly about by kicking their legs and lashing the water with their long tails—and most of them disappear down the throats of hungry fishes. Those who survive grow so fast that their skin becomes too tight for them. So from time to time every little zoëa casts its skin, as a caterpillar does; and every time this happens the wee creature alters its shape in some way. Little feelers, jaws, and walking legs appear; the long spike on its head dis-

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appears, and the long nose grows shorter and shorter. Gradually the zoëa's body broadens and becomes shaped like a shield; its front pair of legs develop tiny claws and its eyes begin to bulge on the end of little eyestalks. It now looks rather more like a crab, of a somewhat odd variety, but it still keeps its long tail and swims about energetically, and feeds and grows and continues to moult about once a week. The baby crab is now called a "megalopa" (mĕg'ă-lō'pă). With every moult its tail grows shorter, until at last nothing but a small, triangular scrap of it remains. This the little megalopa tucks underneath its body, and on that day becomes a real, though very tiny, crab.

Just before its last transformation the little creature, which has now reached the size of a capital "O," sinks gently down to the bottom of the sea; its free-swimming days are over. It now scrambles about on its wee legs in the shallow waters, and sometimes ventures on shore like a grown-up crab. This is a time of great danger for the tiny things. If they had only the sense to keep quiet and not scamper about so much, many more of them would live to grow up; for young crabs are nearly always protectively colored. Those living among seaweeds are green or brown; on sandy ground they are speckled buff, black, and white; and when the shore is muddy they are usually grayish or some dull greenish color. So when they lie still with their tiny legs tucked under them, they are practically invisible. But they are restless, lively little creatures, and when they are scuttling over the rocks or the wet sand, their protective coloring is of less use to them. They are then snapped up by sea birds, waders, and almost any kind of sea creature in search of something to eat. While they are very small they may be caught and swallowed by the sea anemones

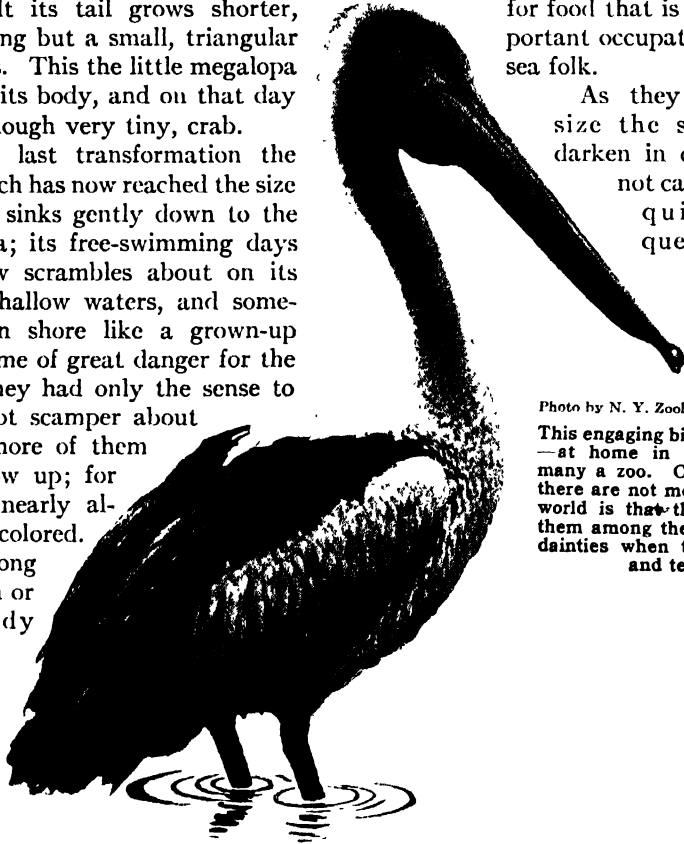
in the rock pools, as they heedlessly scramble about; and many fall victim to their own relatives, for crabs are terrible cannibals.

The young crabs grow very quickly; and as they grow older they grow wiser. They learn caution, and take to hiding themselves, in the daylight, under rocks, stones, and seaweed, or burying themselves up to their funny goggling eyes in the soft sand. When the sun goes down they come boldly forth to join in the unceasing quest for food that is the most important occupation of all the sea folk.

As they increase in size the shore crabs darken in color and do not cast their shells quite so frequently. They moult two or three times a year until

Photo by N. Y. Zoological Society

This engaging bird is the pelican—at home in Europe and in many a zoo. One reason why there are not more crabs in the world is that this fellow finds them among the choicest of all dainties when they are young and tender.



they are full-grown; after that they are content with a complete new suit once a year. It is no easy task strug-

gling out of a tight suit of armor; and when the crab moults he does it thoroughly. He discards every bit of his shell covering, his back shield, his breast-plate, the stiff casing of his legs, foot jaws, antennae, claws, and tail—even the very lining of his gills, his eyes, and all his mouth parts. When, after a desperate struggle, he squeezes himself out through a crack across the back of his shell, between the hind pair of legs, the poor crab is an exceedingly limp and flabby object.

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Photo by F. Martin Duncan

The little crab up in the corner lives in the waters of Central America. In spite of his small size he must be a formidable enemy. Those sturdy claws could

give one a sharp nip. The strange-looking fellow below is the masked crab. He has just come out of a hole in the sand, which you may see at the left-hand side.

This is a perilous time in the life of a crab. To be sure, he is attired in a brand-new suit that has been gradually forming underneath his old one, but at first it is nothing more than a leathery skin. In this state he is helpless. He hastily hides himself away in some secluded spot, trusting that no enemy or close relative will find him out, fall upon him, and devour him.

### Crabs Are Born Fighters

But this sad state of affairs does not last long. The new suit soon hardens. Once more clad like a warrior the crab comes boldly from his retreat, ready to defy the world again. As crabs are much given to fighting they naturally often get wounded. When this happens they will snap off the injured limb and have done with it at once. The loss of a claw or a leg or two affects a crab very little; he makes no fuss, but scuttles about as if nothing unusual had occurred. A new limb soon begins to grow

in place of the lost one, and after the next moult is almost equal to the original one.

A great many crabs besides the common shore crabs live in the shallow waters around the coasts, just on the borders of the great sea world; there they seem to be equally happy in or out of the water. The funny masked crab is one of these border-land crab folk, who, when the tide goes down, often find themselves left high and dry upon the sandy shore. This crab has gained its name from the curious marks on its shield, which give it an absurd resemblance to a human face, or a comic mask. He is a queer-looking fellow altogether. His front pair of legs are more than twice the length of his body and terminate in long, slender claws, while his eight walking legs are of an ordinary size. On the front of his head are two very long, fine antennae fringed with short bristles, which stand stiffly out. Really, he looks more like a Japanese curiosity carved in ivory than a real live crab.

When this little oddity finds the sea has

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deserted him, he at once proceeds to bury himself in the soft, wet sand. He sits bolt upright and digs away for all he is worth with the long, talonlike claws on his eight hindmost legs, at the same time shoveling the loose sand out of the way with his long arm. In this way the crab gradually sinks deeper and deeper into the ground, until at last he disappears altogether. Only two little bristles sticking out from a slight hump in the sand mark the spot where he lies buried. When the sea returns, the little hump of sand cracks, the masked crab heaves himself up to the surface again, and with slow and cautious footsteps moves down to meet the incoming tide.

A female masked crab is not much like the male; her arms are quite short. But she has the same funny face on her back shield and her antennae are almost as long as his. The antennae are very important to the creature, for when they bury themselves the two antennae are brought close together and the bristles with which they are fringed interlock to form a long tube. Through this the water which enables the crab to breathe, is conducted down below.

### Hobgoblins of Crabland

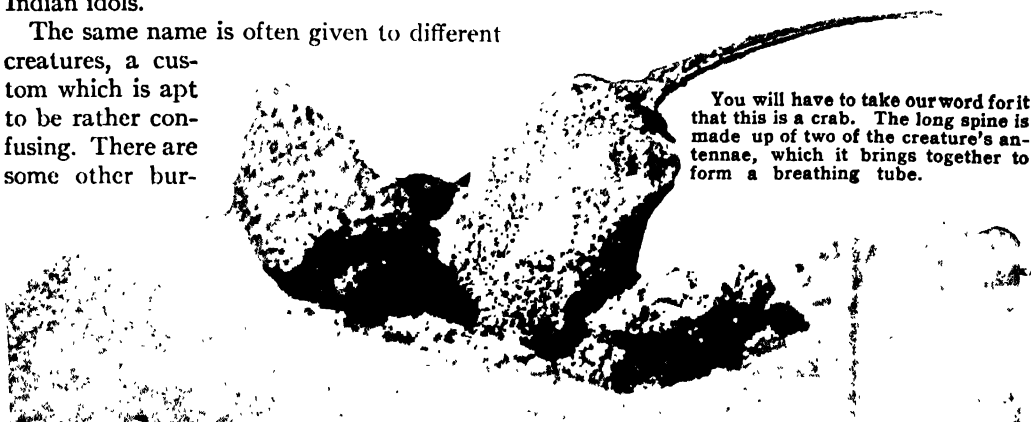
The masked crabs live chiefly in European waters; but the mole crabs, which are very like them in habits, are found on sandy beaches in the warmer parts of the world and on the coasts of both North and South America. Some of the mole crabs of the Indian seas look exactly like strange little Indian idols.

The same name is often given to different creatures, a custom which is apt to be rather confusing. There are some other bur-

rowing crabs, living in shallow waters in tropical regions, that are also called "masked crabs"—or "demon crabs." These take their names from the weird, hobgoblin faces they bear on their backs—like the decorations on the shields of knights of old. One of the most curious of all is the "weeping warrior" crab of Japan. The shield of this odd little animal is so strangely marked that it looks exactly like a Japanese face with tears overflowing from its eyes. According to an old Japanese legend these "weeping warriors" are supposed to be the defeated soldiers who were killed in a great battle between two rival clans of Old Japan.

### How Crabs Fool Their Enemies

Crabs certainly understand the art of camouflage very thoroughly. The little pebble crabs are so like pebbles lying about on the gravelly shore that it is almost impossible to distinguish one from the other; and in tropical seas some of the crabs belonging to the same family look just like fragments of worn coral. This is a natural camouflage. But some of these creatures who are not protected by their shape or coloring deliberately disguise themselves in all sorts of clever ways. The sponge crabs, or "sleeping crabs," as they are called, carry a large mass of sponge on their backs, which lives and grows there until the crabs are entirely hidden beneath it. The last two pairs of legs are much shorter than the others and end in a curved spine. These are used to hold the sponge in position. Some of the



You will have to take our word for it that this is a crab. The long spine is made up of two of the creature's antennae, which it brings together to form a breathing tube.

Photo by F. Martin Duncan



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demon crabs, who have the same useful kind of hind legs, walk about holding a shell or a mangrove leaf over their backs by way of a shield.

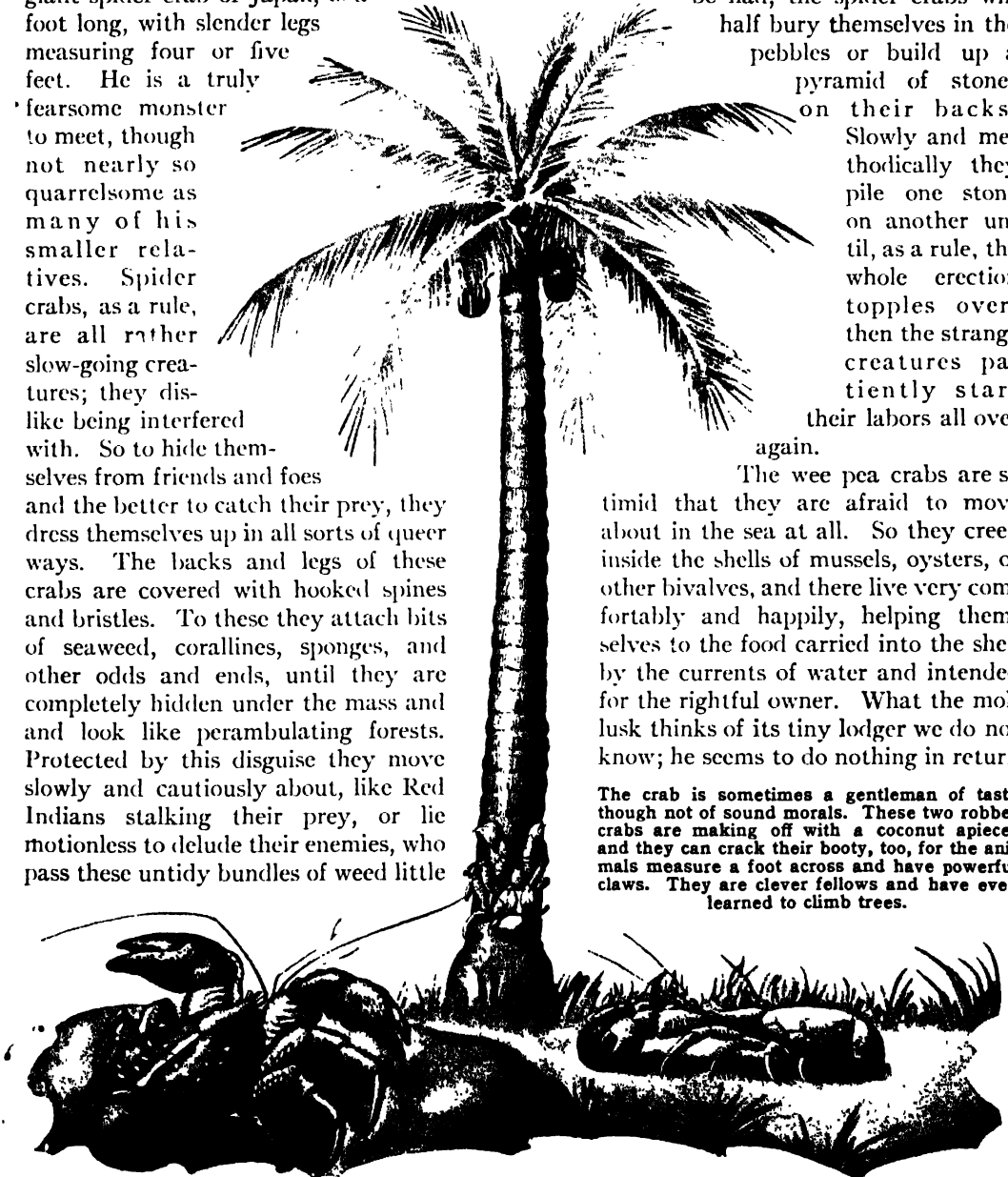
But the spider crabs are the most cunning deceivers of all. There are a great many of them in the seas in most parts of the world. They are of all sizes. The smallest is no bigger than a pea, and the largest, the giant spider crab of Japan, is a foot long, with slender legs measuring four or five feet. He is a truly fearsome monster to meet, though not nearly so quarrelsome as many of his smaller relatives. Spider crabs, as a rule, are all rather slow-going creatures; they dislike being interfered with. So to hide themselves from friends and foes and the better to catch their prey, they dress themselves up in all sorts of queer ways. The backs and legs of these crabs are covered with hooked spines and bristles. To these they attach bits of seaweed, corallines, sponges, and other odds and ends, until they are completely hidden under the mass and look like perambulating forests. Protected by this disguise they move slowly and cautiously about, like Red Indians stalking their prey, or lie motionless to delude their enemies, who pass these untidy bundles of weed little

knowing that the cunning crabs are hidden beneath them. So particular are the spider crabs as to their dress that if you take one arrayed in seaweed and plant him down among masses of growing sponges, he will pick the weeds off his back and legs and cover himself with sponges instead.

If they happen to be living on stony ground where there is very little seaweed to be had, the spider crabs will half bury themselves in the pebbles or build up a pyramid of stones on their backs. Slowly and methodically they pile one stone on another until, as a rule, the whole erection topples over; then the strange creatures patiently start their labors all over again.

The wee pea crabs are so timid that they are afraid to move about in the sea at all. So they creep inside the shells of mussels, oysters, or other bivalves, and there live very comfortably and happily, helping themselves to the food carried into the shell by the currents of water and intended for the rightful owner. What the mollusk thinks of its tiny lodger we do not know; he seems to do nothing in return

The crab is sometimes a gentleman of taste though not of sound morals. These two robber crabs are making off with a coconut apiece; and they can crack their booty, too, for the animals measure a foot across and have powerful claws. They are clever fellows and have even learned to climb trees.



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for being housed and fed in this way. In olden days many people believed that the little pea crabs warned their hosts of approaching danger by nipping them gently with their claws. At this signal the mollusks were supposed to close their shells. But the story is probably not true; the wee crabs are no better than parasites.

The funny old hermit crab also lives in a shell, but he chooses an empty one, a whelk shell or a top shell or perhaps a periwinkle's, whichever happens to suit him best. He has been accused of pulling the rightful owners out of their shells and making a meal of them before taking possession of their houses. Well, he may do this occasionally, but as a rule the hermit when he goes house hunting chooses a house that is already "to let." He is excessively fussy about his portable residence and seldom satisfied for long with the one he is occupying. He thinks every vacant house he sees is better than his own; so he is always moving out of one and into another.

### Why the Hermit Lives in a Shell

When you see a hermit ambling awkwardly along over the sand, his borrowed shell wobbling and rocking from side to side as he goes, you may well wonder why the strange creature should elect to drag a big, cumbersome shell around with him. But just watch him when he is changing houses. When you see him clear of his shell you will understand why he burdens himself in this way. For although his head, his claws, and his two front pairs of walking legs are incased in armor in the usual crab fashion, his hinder parts are quite unprotected. His plump, sausage-shaped body and twisted tail are covered only by a soft skin and would be at the mercy of any creature with sharp teeth,

claws, or beak. One could almost imagine that the hermit crab had the body of some other animal by mistake. The two last pairs of legs are very short and rough at the tips. These and two little peglike projections at the end of his tail, serve to wedge the hermit securely in his shell and prevent him from leaving it behind when he is crawling about. One of the big claws is very much larger than the others. When he retires inside his house the old fellow uses this as a front door to block the entrance and keep inquisitive creatures from annoying him when he is taking a rest.

These crabs are exceedingly quarrelsome, and when two happen to meet they are anything but friendly.

They are almost sure to begin to fight, especially if one of them thinks his brother hermit has a finer shell than he

has. In such a case the envious one at once tries to drag the other out. The two absurd creatures then clutch and claw each other and roll and tumble about until one succeeds in pulling his enemy out of house and home. Then he immediately whips his tail out of his own shell and into the other one and trundles off with it in triumph.

Some hermits always live in a shell that is incrustated with sponges, others are not happy unless an anemone is perched on the top of it. One hermit, who lives in the deep sea, wears a whole colony of small anemones wrapped round him like a blanket, without any shell at all; and some of these odd crabs allow a small bristle worm to share their home. It may be seen popping its head out of the shell and snatching fragments of food from the very jaws of the hermit.

While shore crabs are somewhat slow in their movements, sidling about in a most comical manner, their cousins the swimming



Photo by American Museum of Natural History

The hermit crab above was not altogether satisfied with the house he finally took. He did the best he could to find one to his liking, and then he made certain improvements in the shape of a roof of live sponges planted on his back and a sea anemone to beautify his claw.

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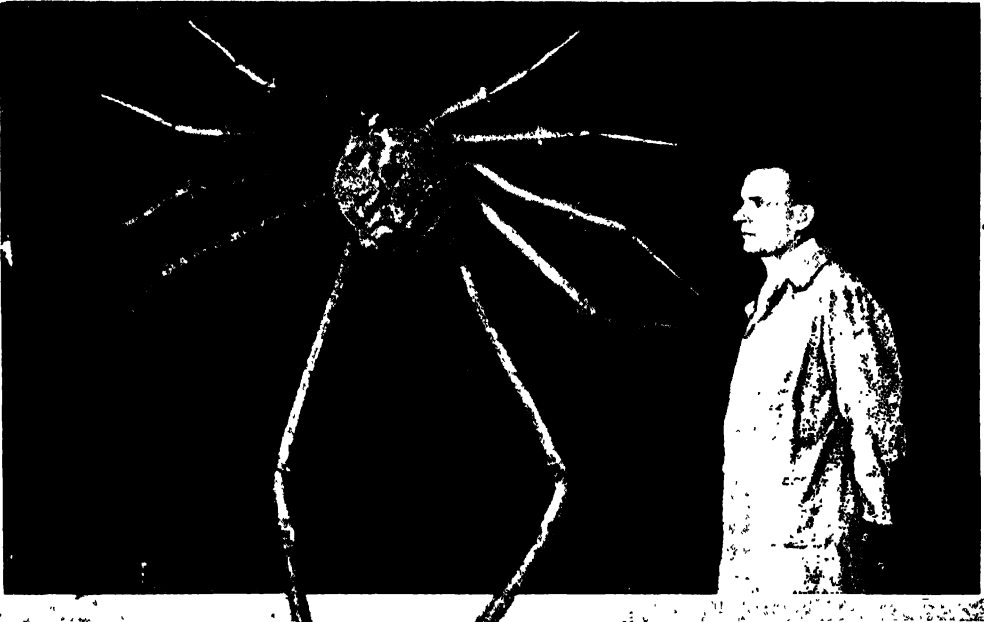


Photo by American Museum of Natural History

A terrible giant spider? No, not at all. It is the Japanese spider crab—biggest of all crab kind. It might be a terrible creature to meet if one were in bathing, but such a thing never happens, for this crab lives only in deep waters.

crabs are much more active in their ways. Their last pair of legs are like broad, flat paddles, which makes it quite easy for the crabs to swim; some of them shoot through the water almost as quickly as fishes do.

The blue crab of the Atlantic coast of North America, which is caught and served at table, is one of the swimming crabs; and the "velvet fiddler," who meets with the same sad fate on the French coast, is another. This crab is a handsome fellow with rather a soft shell clothed with soft, velvety hairs. His swimming legs have somewhat the shape of an old fiddle. He always seems to be in a very bad temper. He foams with rage and clashes his sharp-pointed claws at anyone who dares even to look at him; so the French call him "the angry crab."

Some of the crabs living on the coral reefs in tropic seas have gorgeously colored shells, red, green, blue, or yellow, often marked

with spots or patterns of some contrasting hue. But they are not nearly so conspicuous as you might imagine they would be. For in those wonderful sea gardens, where everything is brightly colored, the gay shells of the crabs are by no means so noticeable as they are when you see them in a museum or an aquarium. Many crabs, too, have strangely shaped shells and claws. The cockscomb crab has enormous claws, scalloped on one edge like a cock's comb. When he folds them in front of his face the two claws fit into each other so exactly that the crab might be shut up in a box. Then there are the stony crabs, so covered with prickles and spines that they are as painful to handle as cactus plants. But there are so many of these queer creatures that we must not spend any more time with them or we shall have none to give to their relatives—the lobsters, prawns, shrimps, and barnacles. That would be a pity, for they are all wonderfully interesting.

All these creatures are called "crustaceans" (krūs-tā'shān), or "crustclad" animals, on account of the stiff, shelly armor with which they are clothed.

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# ***The STORY of LIFE in the SEA***

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## **Reading Unit No. 13**

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### **OUR CRUSTY FRIEND THE LOBSTER**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

How the lobster is fitted for living in the sea, 3-185-86

How the lobster gets a new skin, 3-186-87

Crawfish, prawns, and shrimps, 3-187-89

How barnacles get their food, 3-189

How a young barnacle grows up, 3-190

The king crab's strange appearance, 3-190-92

#### ***Things to Think About***

What does a lobster do when it is about to cast off its old skin?

Of what use to a deep-sea shrimp is its power to produce light?

How do we know that the shelled barnacles are not mollusks?

How does a barnacle use its legs?

What seagoing spider looks very much like a huge crab?

#### ***Picture Hunt***

In what kind of shell is this hermit crab living? 3-185

Why do lobster fishermen often throw female lobsters back into the ocean? 3-186

Of what use to the chick lobster is its spotted shell? 3-187

How does a lobster catch its prey? 3 189

What has happened to the barnacle's feet? 3 190

Why must a ship's bottom be frequently scraped? 3 191

#### ***Related Material***

How did the mantis shrimp get its name? 3-188

Which crab looks like a spider? 3 183

#### ***Leisure-time Activities***

PROJECT NO. 1: Visit the ocean front at low tide and examine wooden piles for barnacles. See if you can find barnacles, be-

low the water surface, in the act of getting food, 3-190-91

PROJECT NO. 2: Examine lobsters and shrimp at a fish market.

#### ***Summary Statement***

Crustaceans are protected by a hard coat over all their soft parts. When the growing crustacean finds its coat too tight, it splits

the coat and crawls out, soft and flabby. The new skin soon gets hard.



Photo by N. Y. Zoological Society

The lobster is plain enough, but can you find the hermit crab? You will need to look in just about the most

unlikely of all places—and even then there is very little of the gentleman to be seen.

## OUR CRUSTY FRIEND *the* LOBSTER

*He Wears as Much Armor as a Knight of Yore, and Is Quite as Bold in Combat*

**F**IRST among the long-tailed tribe of crustaceans comes the lobster. Clad like a knight of old in a complete suit of jointed armor, he moves with much dignity over the floor of the sea—a warrior of the deep.

A full-grown lobster is an imposing person. On European coasts he rarely weighs more than twelve pounds, but an American lobster is much larger and may turn the scale at twenty-three pounds. His shiny, purplish-black coat is splashed here and there with creamy fawn—for of course you know a lobster is not red until it has been boiled—and his long red feelers sweep the water before him as he moves proudly along, feeling his way as he goes.

The head and shoulders of our sea warrior are protected by one large piece of armor called the “carapace” (kār’ā-pās), or “head shield.” The front, or “beak,” projects like the prow of a ship and has a sawlike edge. Behind the head shield are six body rings, each ring slightly overlapping the one behind it and leaving no crack or chink for an enemy’s teeth or claws to get through. The last ring is joined to a “tail piece” that spreads out like a fan to act as a kind of rudder.

The lobster’s mouth is quite as complicated as the crab’s, with different parts for crushing, feeling, and biting; and he has the same kind of funny little jaw feet with which he seizes small morsels of food and crams

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## THE STORY OF THE SEA

them into his mouth. He has the same number of walking legs, and a fine, but decidedly curious, pair of claws, for one is very big and broad and the other is narrow and pointed. The broad claw is the "crushing claw"; with this the lobster crushes his food. The narrower one is the "cutting claw," with which he cuts it up. He has the same queer "pop eyes" set on little eyestalks, and two pairs of feelers, or antennae. The second pair are very long and sensitive; with them the lobster feels his way about and tests every hole before he enters it. Besides all these arrangements the lobster has six pairs of fringed paddles called "swimmerets," one pair attached to each body ring. The last pair, which are larger than the rest, forms the tail fan. With these swimmerets our friend swims easily in any direction he pleases. When going forward he paddles along slowly and steadily, but if he is in a hurry he shoots backwards through the water at a very great rate. He can take tremendous leaps, too, and can creep about over the sea floor on his walking legs. Altogether the lobster is a highly accomplished person.

### Young Lobsters Wear Helmets

A young lobster is not quite such a queer sea baby as a young crab, though it is not exactly like its grown-up relatives. It has a large head shield like a helmet, a row of spines down its back, a forked tail, and no swimmerets; but it uses its legs as oars and rows itself nimbly about near the surface of

the sea. Baby lobsters are plucky little things, and will boldly attack other creatures many times larger than themselves. They spend their early days in the usual happy-go-lucky way, popping about in the water, growing, and eating as much as they possibly can. When they are nearly an inch long the young lobsters sink down to the bottom of the sea, their swimmerets appear, and after each moult they become more and more like their parents.

### When Lobsters Change Their Coats

When about to change his shell the bold sea warrior grows restless and nervous. He seeks anxiously for a secluded nook where he may doff his armor in private without being disturbed while he is as soft and weak as the small fishes he so often bullies. He hunts about, exploring every hole and crevice in the rocks with his long feelers until he finds a place to suit him. Then, when he is quite certain that no hidden danger lurks in its depths, the lobster turns himself about and backs into it.

His next proceeding is to throw up a bank of sand and gravel in front of his cave to form a barricade across the entrance. Then, throwing himself on his side, the lobster begins to wriggle and struggle. His shell cracks all the way down the back, and gradually he drags himself free, pulling out his legs, his tail, his great claws, and every last bit of him, until at last, weak and exhausted, he lies limply beside his old shell.

For a time the poor thing is motionless,

The little oval cut shows the convenient way this lobster has of carrying about her eggs. She folds her long tail under her body and so makes it into a neat little case, in which she may tuck away as many as 100,000 eggs. She carries them in this way for nearly a year.

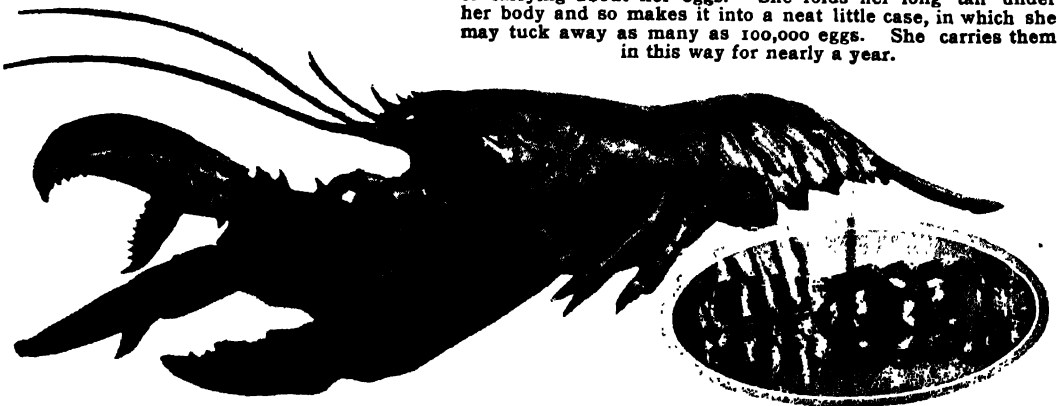


Photo by American Museum of Natural History

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almost as if he were dead. But gradually his strength returns, his new shell hardens, and before many days have passed the lobster is ready to face the world again. He still has to be careful, for it takes a few weeks for his new armor to become as strong and hard as his old suit. Meanwhile he is

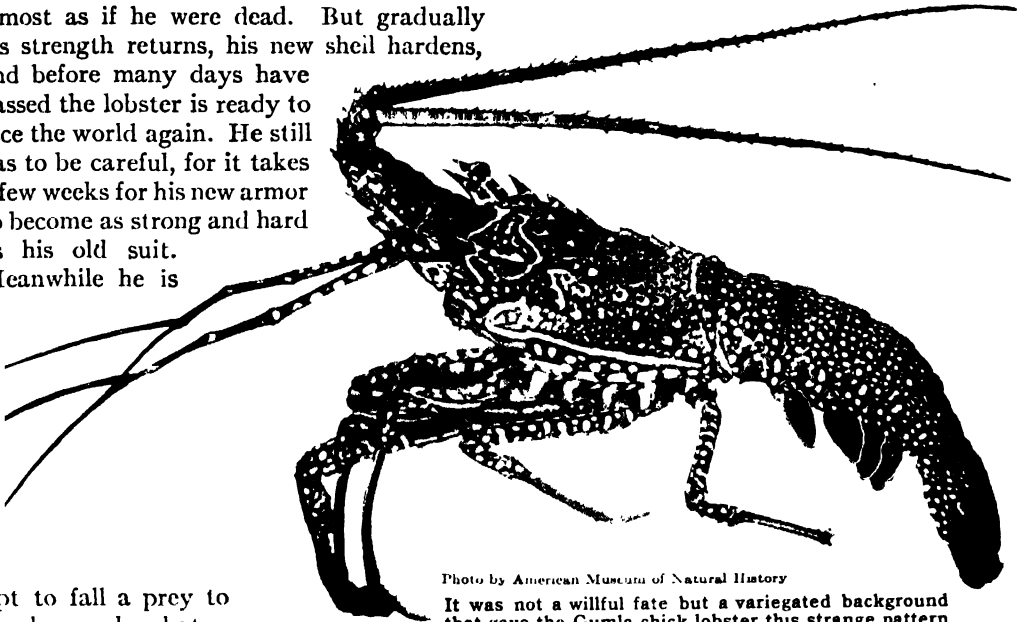


Photo by American Museum of Natural History

It was not a willful fate but a variegated background that gave the Gumla chick lobster this strange pattern of lines and dots.

apt to fall a prey to sharks, cod, skates, and dogfish, who are all on the lookout for him at this time.

Quite as warlike as the common lobsters are their cousins, the sea crawfish, or the "spiny lobsters," as they are called. They are distinguished by having the head shield covered with thorny spines, and have no large pincer claws. All the same, a crawfish can give you a hard nip, for on its first pair of feet it has a sharp spine that closes tightly against a kind of finger.

### How a Crawfish Grunts

Crawfish, or crayfish, have fine antennae, very stiff and thick and often twice as long as the whole body of the animal. If the creatures are taken from the water they express their displeasure by grunting. This they do by rubbing the bases of their antennae against the rough edge of the head shield. In the tropics crawfish are very brightly colored. They are found in the warmer seas in all parts of the world and are fond of hiding under rocks and stones.

One can tell at a glance that prawns and shrimps are related to the lobsters, as the active little fellows are so like them in shape. They, too, have shelly head shields and overlapping body rings; but their armor is so

frail that it is easily crushed and affords them but little protection against the snapping jaws of hungry fishes, who are particularly fond of shrimps and prawns for supper. These small crustaceans would fare badly if they exposed themselves recklessly to the sharp eyes of flesh-eating sea creatures. They are well aware of this; so during the day the wise little shrimps shuffle themselves into the sand and even sprinkle a few grains over their backs. Since they have pale brownish speckled coats they are almost invisible. At night they pop up, dart here and there in the water, and join in the general hunt for something to eat.

### How to Tell Prawns from Shrimps

Prawns, when they are full-grown, live, as a rule, in deeper water; but while they are young they keep nearer to the shore and are often mistaken for shrimps, although they are not really exactly alike.

It is simple enough to tell one from the other after they have been boiled, for prawns turn a pretty pink color and shrimps are always brown; but it is not quite so easy to distinguish the little creatures when they are in the water. For one thing they are

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remarkably transparent, especially the prawns, who might be made of glass. They look like tiny shadows in the water, as they cluster together in the shade of the rocks and stones, just moving their long feelers from side to side and turning first one way and then another with little jerky movements. If you look at them carefully, however, you will soon discover which is which. The prawn has three pairs of long feelers and its head shield projects in front like a long, jagged sword; its color is a shadowy gray with faint wavy lines of green and purple. The shrimp has only one pair of feelers on each side of its head and no sword as its head shield. Its body is flatter and its legs are shorter than a prawn's, and on each side of its head it has a curious projection rather like a rabbit's ear. Moreover, prawns come up to the top of the water more frequently than the shrimps, who spend most of their time on the sandy bottom of the sea.

There are many strange shrimps and prawns to be met with on our travels in the sea world. On the coral reefs, in a hole or crevice in the coral rocks, lives the curious hooded shrimp, whose eyes are quite hidden under its head shield. One of its pincers is of huge size and very brightly colored. With this curious instrument the shrimp makes a sharp, clicking sound whenever it is annoyed or frightened in any way.

The mantis (mă'n'tis) shrimp is another queer crustacean of the warmer seas. It has gained its name from the resemblance of its great claws to the forelegs of the mantis insect, which fold back like a knife blade. With these fearsome weapons the shrimp, like the insects, seizes and holds fast any unfortunate little creature that ventures too near. Some of these weird sea creatures are more than a foot in length, more like lobsters than shrimps in size.

Then there are the opossum shrimps—tiny creatures less than an inch long who carry their young ones about in a little pouch;

and there are the long-horned shrimps which, in spite of having so many legs, use their long feelers for walking as well. They are fierce and quarrelsome little things, and are often to be seen hunting about in small packs, stirring up the sand with their extraordinary "horns." If one of them unearths a worm, all the others dash upon it and pull and tug at the poor thing like a pack of dogs fighting over a bone.

But stranger still is the "skeleton shrimp," or "specter shrimp," with its long, lean body, round head, and hooked, club-shaped claws. All its legs, except the first pair, are placed at the tail end of the creature, and it creeps about over the seaweed and sea firs like a looper caterpillar. Skeleton shrimps are always fighting one another. But a mother skeleton takes good care of her babies. She keeps them at first in her pouch; but as soon as they are strong enough to scramble out, the wee things climb up on her back. There, sitting bolt upright, they cling lightly to their mother with their hind legs and wave their long feelers about in a most ridiculous way.



Photo by F. Martin Duncan

This strange device that looks as if it might have been made out of ribbon is the dainty mantis shrimp.

The mantis shrimp, the opossum shrimp, the longhorn, and the skeleton shrimp are not true shrimps, although they are related to them. The last three are called "amphipods" (ăm'fĭ-pôd)—which means "having feet on all sides"—because they have so many feet on their heads and chests and tails. True shrimps and prawns, like the crabs and lobsters, never have more than ten.

### Shrimps That Carry Lanterns

Many deep-sea shrimps and prawns give out light as fireflies do. Some have great illuminated eyes that shine like searchlights in the water; others have rows of lights all along their sides and on their tails. One brilliant scarlet prawn sends out such a fiery glow from all his lamps that he moves through the sea surrounded by a perfect blaze of light. In the dark depths of the



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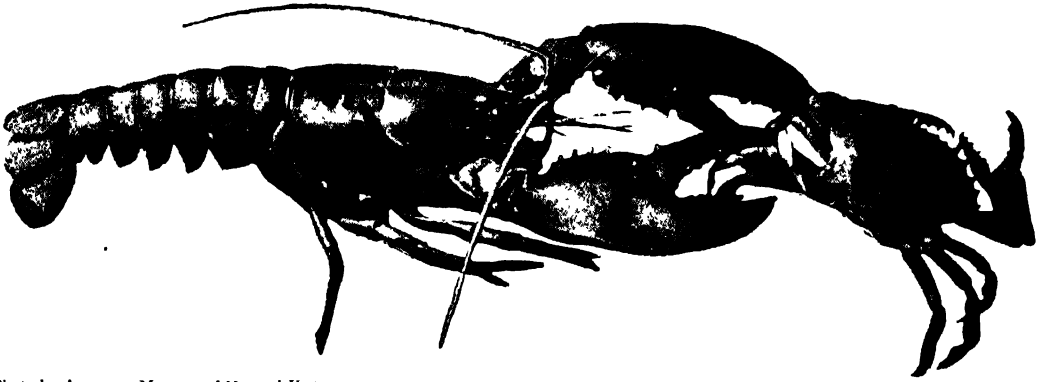


Photo by American Museum of Natural History

The crab is going to have a hard time getting free of this lobster's great claws. For once a lobster takes

hold he never lets go! He would rather lose his claw than give up the battle, once he has come to grips.

ocean in which he lives, this fiery cloud is probably as useful to the prawn in confusing his enemies as the "smoke screen" poured out by the octopus and squid in shallower waters.

### The Lobster's Curious Cousin

Now there is a marked family resemblance among all the crust-clad sea folk—the crabs, the lobsters, shrimps, and prawns. Although each tribe has, of course, its own peculiarities, it is not as a rule very difficult to recognize members of this class when we meet them. But there are some curious crustaceans so unlike all the rest that it would puzzle anyone who was not very well informed to say exactly what they were. Indeed, for a long time even learned professors believed them to be mollusks. These odd crustaceans are called "cirripeds" (sir'i-pēd)—which means "feather feet"—because they have feet which look like curly ostrich feathers. But ordinary people like ourselves call them barnacles (bär'nä-k'l).

### Living Acorn Shells

Everyone who has spent a holiday by the seaside knows what acorn shells are like; and those who have clambered over the low rocks when the tide is out know, too, how painful are the sharp, jagged edges of the limpetlike things. These acorn shells are barnacles. They cluster in hundreds on rocks and breakwaters and on the piles of old wooden piers. When they are empty they look like miniature volcanoes; but when

the barnacle is "at home" the shell is closed by a neat little lid, fitting just inside the top of the crater, made of four little valves coming together at the center in a point.

Listen! Do you hear a funny little rasping noise? The sound is coming from the acorn shells. The barnacles are impatient as they wait for the turn of the tide, and when they move restlessly inside their houses, the edges of the four little valves rub together. At last the water flows in and covers them again. One after another the little trapdoors open, and out of each acorn shell pops a bunch of purple feathery things that spread out in a circle and begin to bend and sway about, now on one side, now on the other. Then quite suddenly the feathers are drawn back into the shells and the tiny doors clapped shut.

### How the Barnacle Gets His Dinner

These feathers are not feelers. They are the barnacle's legs. They are long and slender and fringed with delicate hairs; and the little creature to whom they belong spends its life alternately shooting them out of its trapdoor and pulling them back into its house again. The feather legs are in fact used as a casting net. Joined together by the network of fine hairs with which they are covered, they sweep through the water collecting the tiny living things with which the sea is always crowded. Then, when the barnacle has a good haul, it draws in its net and digests its dinner.

Like all crustaceans the barnacle is obliged

## THE STORY OF THE SEA

concealed under his shell. This shell is as broad as it is long, rounded like a dome, and is usually of a dark sage-green color. Although he burrows in the mud or sand, the king crab always keeps himself scrupulously clean, as he is very careful about his appearance.

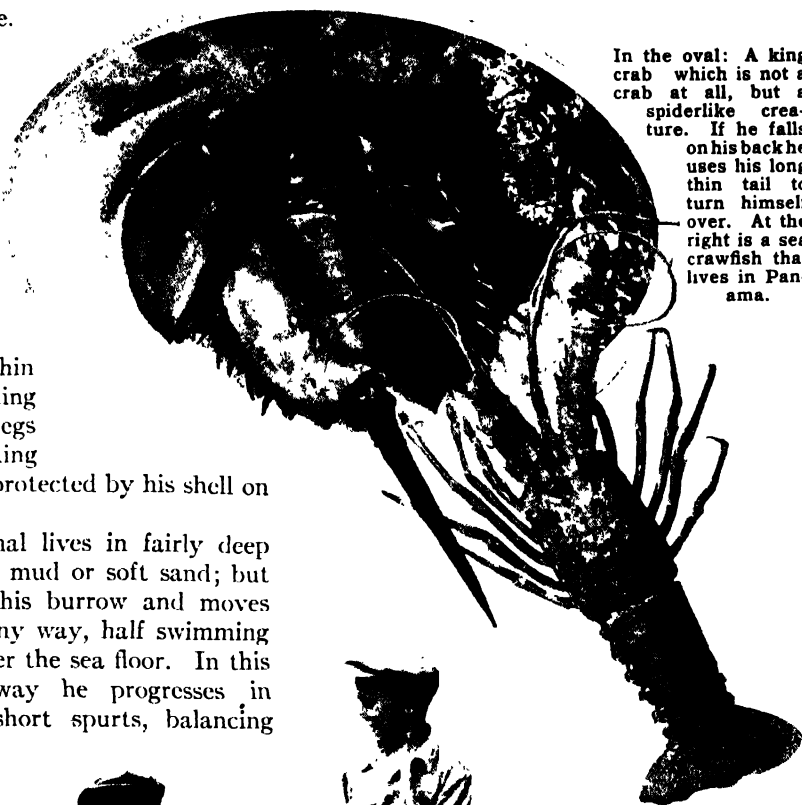
You would expect under this great domelike shell to find a large and plump individual; but turn him over and you will see that the animal is really so thin and hollow it looks as if he had been scooped out with a spoon. Within the hollow body the king crab withdraws his legs when he is not walking about; so he is well protected by his shell on every side.

This strange animal lives in fairly deep water, buried in the mud or soft sand; but at night he leaves his burrow and moves about in a very funny way, half swimming and half hopping over the sea floor. In this way he progresses in short spurts, balancing

himself for a moment on the tip of his long tail after each effort.

It is interesting that this distant relative of the spiders and scorpions should have got himself up to look like a crab.

In the oval: A king crab which is not a crab at all, but a spiderlike creature. If he falls on his back he uses his long thin tail to turn himself over. At the right is a sea crawfish that lives in Panama.



In many ports public fishing boats leave shore every morning with passengers eager to cast a line into the sea. Many of those fishermen have never angled in salt water before, and for them the small boat fare purchases a day of rare sport.

Photos by American Museum of Natural History and F. Martin Duncan

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# *The STORY of LIFE in the SEA*

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## **Reading Unit No. 14**

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### **STRANGE FISH, FIERCE AND FRIENDLY**

*Note: For basic information not found on this page, consult the general Index, Vol. 15*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How a typical fish is designed, 3-195-96  
What happens to great schools of fishes, 3-197  
Why the shark is so unpopular, 3-197-99  
Relatives of the shark, 3-200-1  
Flatfishes and how they grow flat,

3-202-4  
Protective coloration in fishes, 3-204-5  
Flying fishes, 3-205-6  
Why fishes have such large families, 3-208  
Sea horses, 3-215

#### *Things to Think About*

How are fishes built for life in water?  
How can a flatfish "mimic" its surroundings?  
Why do some fish change color?

Of what use to deep-sea fishes are light organs?  
Why is not the ocean filled with fish?

#### *Picture Hunt*

How does a fish get oxygen from sea water? 3-196  
Why are some rays dangerous to man? 3-198  
What happens to the left eye of a flatfish? 3-203  
Why are flatfishes hard to see on the ocean bottom? 3-204

Why must coral reef fishes be brilliantly colored? Color plate 3-118; also opp. page 3-198  
How does the angler fish get its dinner? 3-209  
What fish builds a nest and guards its young? 3-210

#### *Leisure-time Activities*

**PROJECT NO. 1:** Visit an aquarium, fish market, tropical fish exhibition, or a museum in order to grow familiar with a

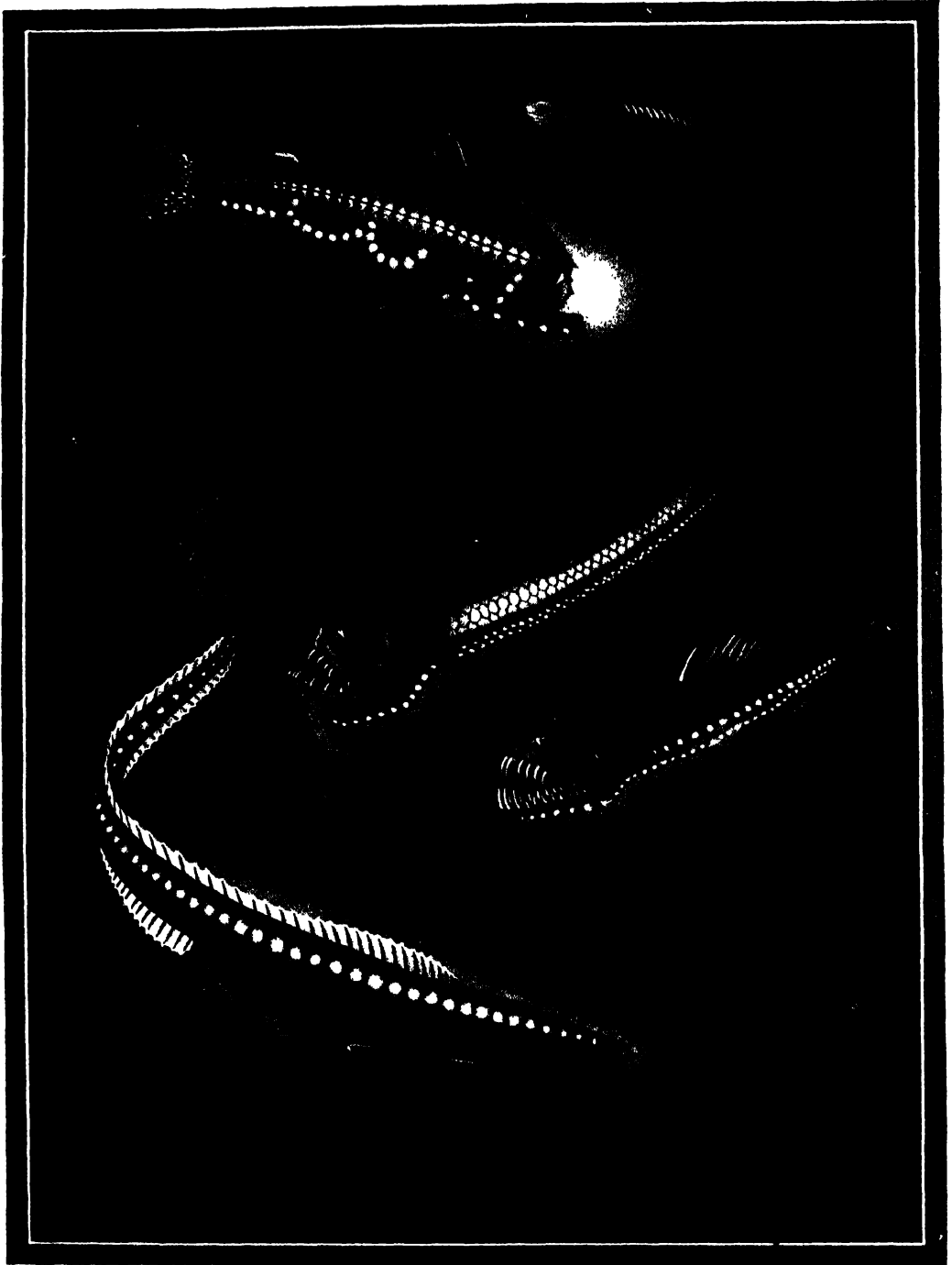
great variety of fishes.  
**PROJECT NO. 2:** If possible, go on an ocean fishing trip in a large boat.

#### *Summary Statement*

Marine fishes show a great variety of sizes, shapes, colors, and habits. Most of them are cannibals and all of them are constantly hungry. Some fishes change color in order to blend

with the surroundings and thus escape being eaten. Most fishes neglect their many eggs, but some, like the sea horse and stickleback, protect them.

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Painted Especially for This Work

They carry their flashlights with them wherever they go! For if you are going to spend your life in the dark, you surely must have some means of finding your way about. So the deep-sea fishes are provided with rows of "lamps." Mr. William Beebe discovered that around Bermuda fish living near the surface tend

to be dark above but light-colored below, so as not to show against the sky if looked at from beneath. Somewhat farther down the fish are all transparent and look like ghosts in the dim twilight. And in the pitch-black depths where no ray of light can reach, all the little fish carry their own lighting systems.



Photo by N. Y. Zoological Society

This interesting trio is made up of an angel fish, a trigger fish, and a skate. The angel fish, at the left, is covered with brilliant hues, for he lives on coral reefs. The trigger fish, in the center, gets his name from the fact that one of the spines on his back is

held up by a clever device on the spine behind it, and cannot be laid flat until the second spine has first been laid down. The skate, at the right, is a sluggish fish that lives on the sea floor and is colored to look like its muddy or pebbly background.

### STRANGE FISH, FIERCE *and* FRIENDLY

*If You Tried from Now till Doomsday, You Could Never Think  
Up the Like of All the Strange Creatures That Ride  
Around on Their Fins*

**O**F ALL the creatures that live in the great sea world none seem more truly at home and in their right element than the graceful fishes. Light and graceful as birds in the air, they move through the water, rising, falling, twisting, turning with such marvelous ease it is a joy to watch them.

The shape of a fish is the very best possible one for a free, wandering life in the ocean. We are content to build our ships on the same plan, long, narrow, and pointed at the prow, so that they cleave a path through the water with the greatest ease.

The fish swims and steers and keeps its balance with its fins and its tail. The fins are folds of skin supported by bones arranged like the ribs of an umbrella. These bones are called the fin rays. A typical fish has fins along the ridge of its back and underneath its body, a tail fin, and two pairs of side fins corresponding to the four legs of a quadruped, or to our own arms and legs. It has, too, as a rule, a wonderful contrivance called a "swim bladder" just under its long, flexible spine. This swim bladder is rather like the gas bag of an airship, and is inflated

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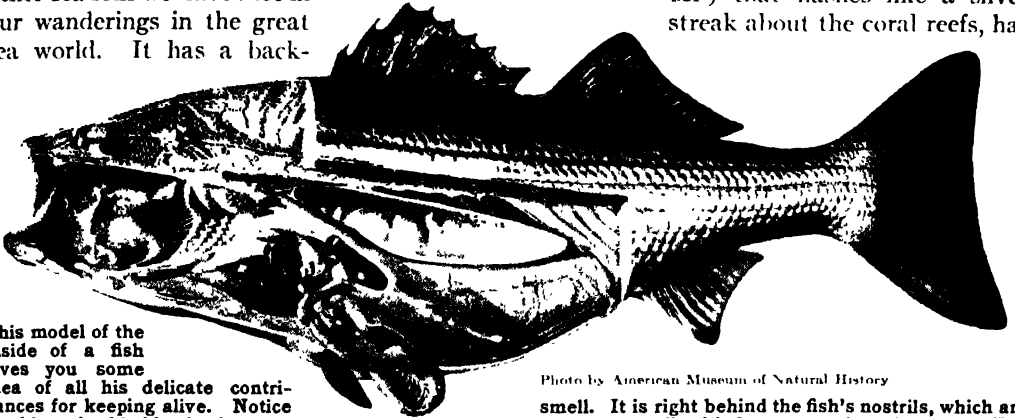
or compressed as the fish rises or sinks in the water.

A great many fishes are clothed with soft scales. They are embedded in the skin, as our finger nails are, and overlap one another like shingles on the house top. It is these scales that give the fishes their wonderful glittering colors. Some fishes have no scales but are simply clothed with skin, while others are incased in an armor of strong, bony plates.

In one way a fish is superior to all the other sea folk we have met in our wanderings in the great sea world. It has a back-

queer fish of all sorts, sizes, and descriptions. They are just as varied, too, in their habits. There are wandering fishes that travel ceaselessly about the ocean, never resting at the bottom of the sea or idling in coral gardens. They swim, feed, pursue their prey, fight, and even sleep in mid-water. Some fishes hardly use their fins at all, but merely flop about on the sea floor. Others have real homes of their own, which they vigorously defend against all comers.

The dainty little "demoiselle" (dē-mwá-sěl') that flashes like a silver streak about the coral reefs, has



This model of the inside of a fish gives you some idea of all his delicate contrivances for keeping alive. Notice the big swim bladder in the center, which may be blown up or let down according as its owner wants to rise or sink in the water. You can see, too, what is the tiny beginning of a brain. It is the little group of knobs you will find not far from where the fish's eye should be. The long cord they are strung on is the spinal cord, and the little knot at the front end of it consists of the nerves of

Photo by American Museum of Natural History

smell. It is right behind the fish's nostrils, which are used to smell with but not to breathe with. The fish breathes through his gills, delicate feathery organs that you see lying in bands just behind the large chamber that the mouth seems to open into. Water is taken into the mouth, flows through the gills, where the oxygen is taken from it, and then flows out of the slits you see at either side of a fish's head. A sieve strains the water going to the gills.

bone, and so belongs to the higher order of "vertebrates" (vŭr'tē-brāt), or back-boned animals. But a fish breathes with gills, just as other sea creatures do. Water flows through its mouth into two spaces—called gill cavities—one on each side just behind the head. Then, after the oxygen has been extracted by the gills, the water passes out again through five little slits—the gill clefts—in the fish's throat. The gills are like bright red tassels; and the gill slits are protected by a small movable flap called the gill cover.

### From Fairy Fish to Ugly Monsters

Of course fish are not all exactly alike in every particular. There are huge fish and fairy fish, round fish and flat fish, ugly monsters and little jewels of fishes, as well as

a particular hole or crack in the rocks as its own especial residence. There it rests in solitary state, keeping a sharp lookout to sea and darting like a tiny fury at any other fish who blunders too near its coral home.

### This Fish Climbs Out on the Rocks

The quarrelsome little blennies live in holes in the rocks on the seashore, and fight any other fish who drops in to pay a call, hanging to their visitor with their very sharp teeth, like little bulldogs. The blenny is a sturdy little fish with a big head and bulging cheeks. It is an odd fellow in several ways, for not only does it climb over the rocks on its fins, but it is able to pass two or three hours out of water quite comfortably, and is fond of taking an air bath on a rocky ledge just above the level of the water.

## THE STORY OF THE SEA

Some fishes are very unsociable and prefer to wander about alone; others like company and swim together in schools or shoals. Herring and mackerel often travel together in enormous shoals, their dense moving masses actually rippling the surface of the water as they swim along in close formation. Huge armies of herring move about the sea in columns several miles in length and breadth, accompanied by whales, sharks, dolphins, cod,

a hundred thousand herring in a single day.

First among the fierce, hunting fishes we must rank the sharks. They are the tigers and vultures of the sea, and no one has a good word to say for them. Thrilling tales are told by travelers and sailors of terrific encounters with these unpopular giants. Many, no doubt, are true, or partly so; but some at least are pure fiction.

Truth to tell, the shark is a lazy, awkward fellow and a bit of a coward. But like all cowards he is a bully. He will snap at any inoffensive sea creature who crosses

and other big fishes, who snap them up and make great gaps in their ranks. Flocks of excited sea birds follow overhead, diving with shrill

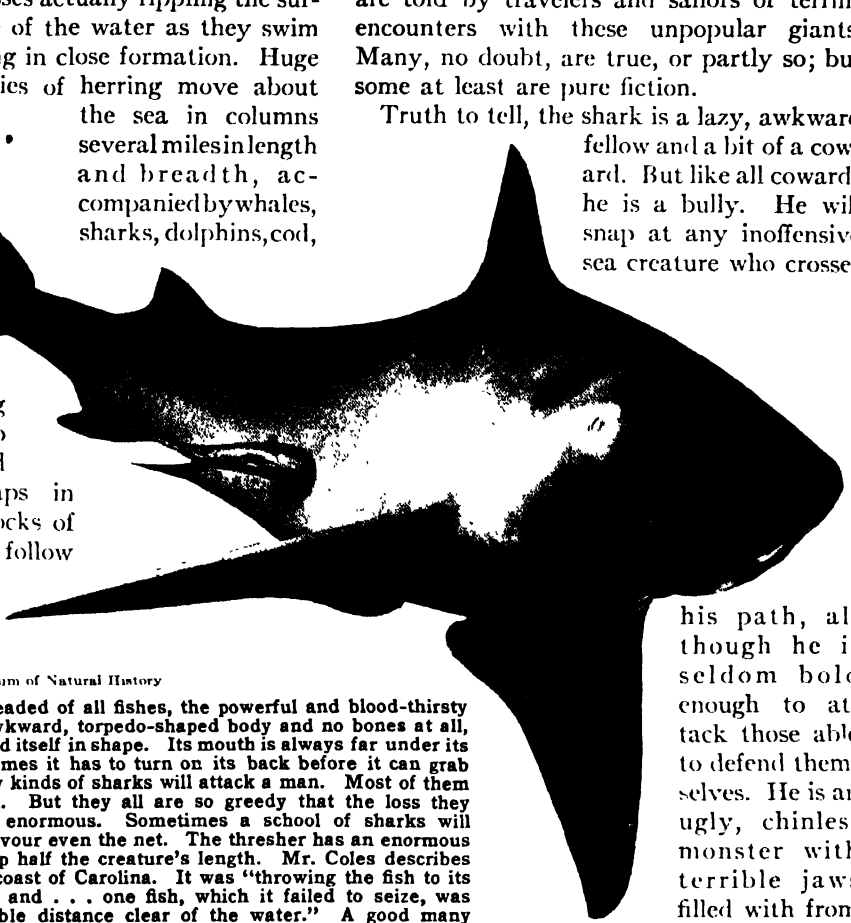


Photo by American Museum of Natural History

This is the most dreaded of all fishes, the powerful and blood-thirsty shark. It has an awkward, torpedo-shaped body and no bones at all, but only gristle to hold itself in shape. Its mouth is always far under its head, so that sometimes it has to turn on its back before it can grab its prey. Only a few kinds of sharks will attack a man. Most of them live entirely on fish. But they all are so greedy that the loss they cause fishermen is enormous. Sometimes a school of sharks will attack a haul and devour even the net. The thresher has an enormous tail, which makes up half the creature's length. Mr. Coles describes one he saw off the coast of Carolina. It was "throwing the fish to its mouth with its tail, and . . . one fish, which it failed to seize, was thrown a considerable distance clear of the water." A good many sharks do not lay eggs, as other fishes do; the baby sharks are born alive instead of hatching out. If you look closely you will see what looks like a small fin in the middle of the creature's side. But it is not a fin at all. It is a little fish that has learned how to ride about the world on the very enemy that would be most glad to eat him if it could. He attaches himself to a shark or other large fish by means of a big flat disk on his head. It has been made out of a fin, and forms a vacuum cup when pressed against a hard surface. In this way the smaller fish can hang on as long as he likes. He is even used to angle with in some of the southern seas. For if he is let loose in the water with a line attached to him, he will fasten himself to a turtle or some large fish and so bring the creature with him when he is hauled to the boat.

cries into the water and darting aloft again with glittering silver fishes in their beaks. At certain times of the year the shoals of herring and mackerel visit the coasts, where they are netted in enormous numbers. A single fishing boat will sometimes catch over

his path, although he is seldom bold enough to attack those able to defend themselves. He is an ugly, chinless monster with terrible jaws filled with from

three to six rows of sharp, pointed teeth—not at all the sort of sea person we should care to meet when diving or bathing.

Sharks are greedy things. They are genuine garbage collectors, and will eat almost anything. They follow ships and dash at everything thrown over-

board; they will even gulp down the cinders flung from the stokehole! If a fight is going on between other fishes, the sharks will hover round the combatants and rush in and attack those who are getting the worst of it; and they at once set upon and devour every

## THE STORY OF THE SEA

injured animal they come across. No wonder sharks are not favorites with either sea folk or human folk.

These unpopular sea giants are to be met with in most parts of the world, though they are more numerous in the warmer seas. They are great wanderers. The Greenland shark, for example, whose natural haunts are in the Arctic re-

is about twelve or thirteen feet long and has an extraordinary head the shape of a hammer. Its wicked-looking eyes are placed on at each end of the hammer head, and its mouth, full of horrible, crushing teeth, is just below. The thresher shark, sometimes called the fox shark, is about fifteen feet long; but quite half the length is accounted for by its ex-

Photo by American  
Museum of Natural  
History

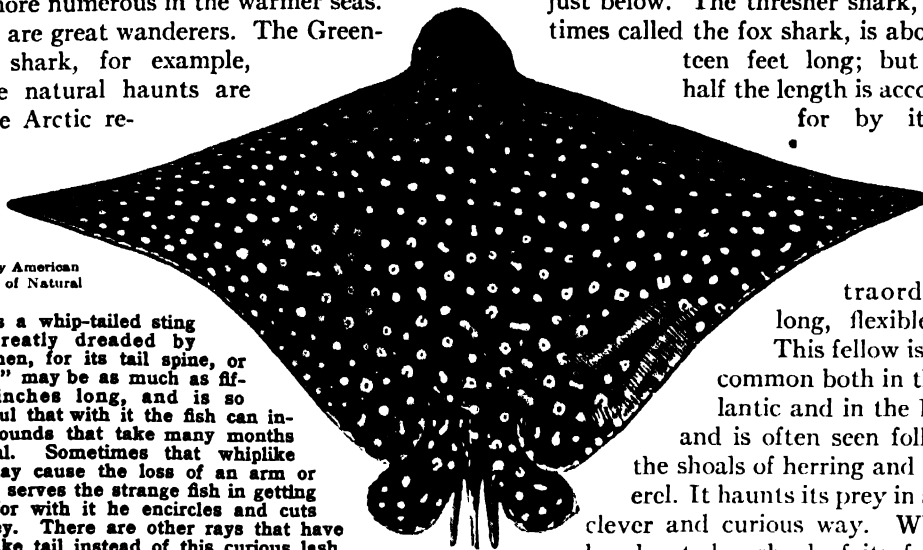
This is a whip-tailed sting ray, greatly dreaded by fishermen, for its tail spine, or "sting," may be as much as fifteen inches long, and is so powerful that with it the fish can inflict wounds that take many months to heal. Sometimes that whiplike saw may cause the loss of an arm or leg. It serves the strange fish in getting food, for with it he encircles and cuts his prey. There are other rays that have a fishlike tail instead of this curious lash, but all of them have powerful means of defense. The electric, or torpedo, rays carry in their heads a little organ for generating electricity. They can numb their enemies with an electric shock, and can completely disable a man. Certain kinds of rays get to be as much as seven or eight feet across.

gions, sometimes strays as far from home as the coasts of France on one side of the Atlantic and Cape Cod on the other. It is a great clumsy brute, twenty-six feet long, a sworn enemy of the "right whale"; but instead of attacking the whale openly it swims stealthily up to it and bites large pieces out of the poor thing!

### A Head like a Hammer

The great white shark, one of the largest of its tribe, sometimes measures forty feet from its snout to the tip of its tail fin. We do not meet with such monsters often; from twenty to thirty feet is a more usual size—and that is quite large enough. Although called the "white shark" this monster is really an ashen gray color and white only underneath its long body. It wanders to and fro in the warmer seas and rarely enters cold waters.

Two very curious sharks are the "hammer-head" and the "thresher." The hammerhead



traordinary  
long, flexible tail.

This fellow is quite common both in the Atlantic and in the Pacific and is often seen following the shoals of herring and mackerel. It haunts its prey in a very clever and curious way. When it has located a shoal of its favorite fish it swims round and round it in gradually diminishing circles, thrashing the water with its tail all the time. The poor fishes huddle closer and closer together in their fright and fall an easy prey to the cunning shark.

The blue shark, though it rarely exceeds six or seven feet in length, is one of the most troublesome of these greedy, hunting fishes. It comes into the fishing grounds and is up to all sorts of mischief, cutting the hooks from the fishing lines with its sharp teeth, biting large pieces out of the nets, and sometimes completely rolling itself up in one!

### Greedy Sea Hounds Hunt in Packs

Dogfish, too, are a great nuisance to fishermen, for they follow the shoals of herring, mackerel, and whiting and destroy great quantities of fish. Dogfish, or "sea hounds," as they are sometimes called, belong to the shark family and are even more troublesome than their big relatives. They are most fierce and ravenous creatures, hunting the seas in packs, as wild dogs hunt in the wilderness.



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## THE STORY OF THE SEA

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Painted Especially for This Work

*Here are some of the gorgeous creatures that flaunt about in the deep. Most of the familiar fishes that we catch in lakes and streams are soberly clad little things, whose colors blend with the rocks and sandy*

*bottoms where they dart about. But a fish that lives on a coral reef or in a garden full of sea anemones and other brilliant sea folk must wear a suit to match his background or he will soon be gobbled up.*

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## THE STORY OF THE SEA

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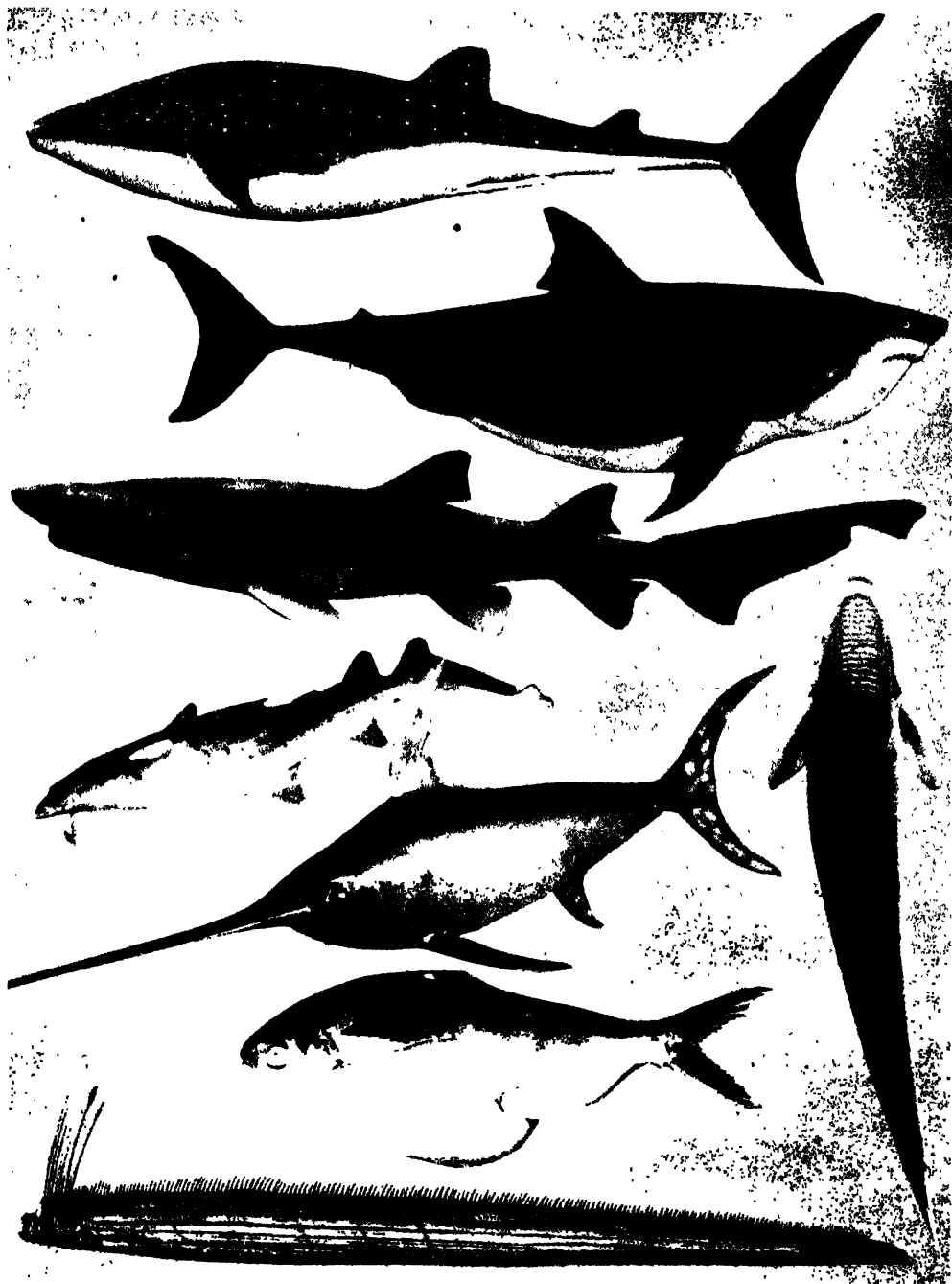


Painted Especially for This Work

Some fish have developed queer habits. For instance the gurnards all have a number of spines growing under the head. These they can move about, so as to use them for walking on the sandy bottom and for

feeling about for food. And not satisfied with getting along by both swimming and walking, the flying gurnard has developed a pair of his fins into beautiful spotted wings on which he can sail into the air.

## THE STORY OF THE SEA



Photos by American Museum of Natural History

At the top of the page is the whale shark, as much as fifty feet long and probably the biggest shark of all. It is quite harmless. Second from the top is the man eater. Next comes the West Indian shark, and then the greedy sand shark. Below is the swordfish, and

then an unlucky butterfish with a piece gone from his stomach. At the bottom is the eel, over twenty feet long and colored a silvery blue with red fins. And at the side is the remora, with a vacuum cup on its head for holding it tight when it rides on a shark.

## THE STORY OF THE SEA



above the large gaping mouth are two round spots like staring eyes; and the queer fish looks for all the world as if it were chuckling at our astonishment. Of course these spots are not eyes. The real eyes are on the other side, on the top of its head, placed in the usual way so that the ray may see

The rays, or skates, do not look at all like the sharks and dogfish, yet we know they must be related, for they have exactly the same kind of armor—made

Photos by American Museum of Natural History and N. Y. Zoological Society

This prickly skate is, as you may have guessed, a close relative of the ray. The skates and rays are all broad and flat and live almost entirely on the sea bottom. So their upper side, shown above, is always colored in such a way as to make the fish hard to see, and the under side, shown at the right, is a dead white.



up of flat, bony plates imbedded in the skin—and skeletons of tough gristle instead of bone. There are a great many different kinds of these strange fishes, but there is a general family likeness among them all. They are very broad and flat and have large side fins that flap like wings as they move in leisurely fashion through the water.

Rays do not travel about the ocean as the sharks do. They are lazy and usually harmless creatures, spending a good deal of their time lying flat on their faces, half buried in the sand. As the back of a ray is always more or less colored to tone with the ground it rests upon, it is difficult to see them at all unless they move. When one of these big flat fishes suddenly heaves itself up from its bed and starts flopping about, like a kite trying to rise in the wind, one is greatly surprised, for the under side of a ray is exactly like a flat, white, grinning face. Just

its way about as it flaps along and spies out the mollusks and crustaceans which it engulfs with its big mouth and crushes with its strong teeth.

King of his tribe is the great eagle ray, or the "devilfish," as he is often called because he wears a dark cloak, has two horns on his head, and a funny little tail. Without doubt he is an appalling-looking creature, and if not the longest, he is certainly the broadest, of all living fishes. Round about the West Indies you may meet with a devilfish measuring twenty feet across from edge to edge of his side fins, and supplied with a mouth four feet wide full of great pavements of terrible, grinding teeth. No wonder divers are terrified at the sight of such a demon, and believe these creatures will wrap their great wings round them and crush them in their jaws.

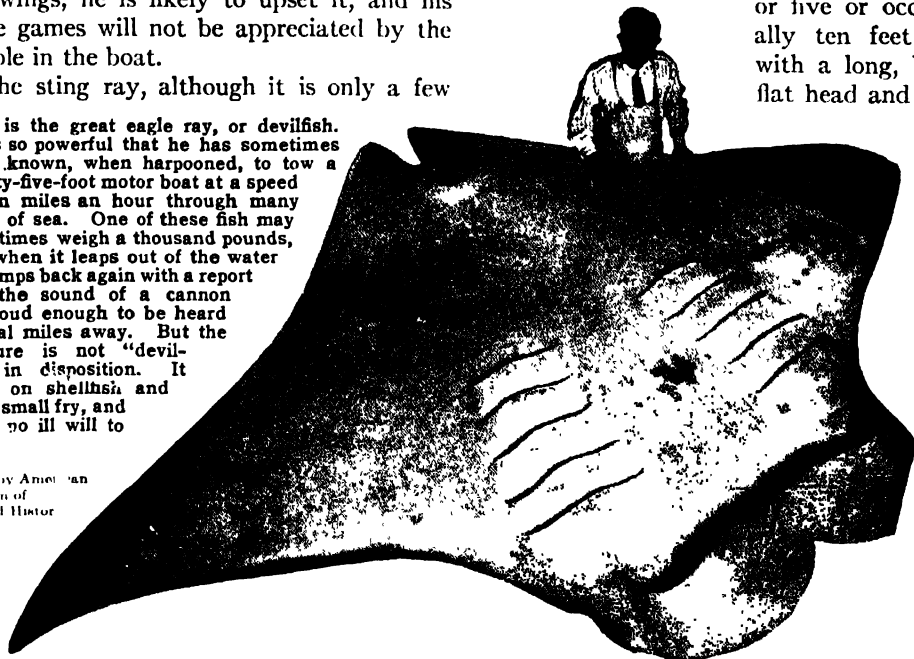
## THE STORY OF THE SEA

But the eagle ray is not nearly so black as he is painted. In spite of his huge size and his truly fearsome appearance, he is just a clumsy and somewhat lazy monster intent on hunting crabs and mollusks, which he crams into his mouth with his two little horns. Of course if he gambols round a small rowing boat and slaps it playfully with his wings, he is likely to upset it, and his little games will not be appreciated by the people in the boat.

The sting ray, although it is only a few

This is the great eagle ray, or devilfish. He is so powerful that he has sometimes been known, when harpooned, to tow a twenty-five-foot motor boat at a speed of ten miles an hour through many miles of sea. One of these fish may sometimes weigh a thousand pounds, and when it leaps out of the water it thumps back again with a report like the sound of a cannon and loud enough to be heard several miles away. But the creature is not "devilish" in disposition. It feeds on shellfish and other small fry, and bears no ill will to man.

Photo by Amelia  
Museum of  
Natural History



feet broad, is a dangerous fish to encounter. Its long, whiplike tail is armed with a sharp, barbed spine eight to fifteen inches long, which inflicts an exceedingly painful and poisonous wound on anyone rash enough to interfere with it. Another remarkable member of the ray tribe, the electric or torpedo ray, carries a pair of electric batteries in its head and stuns its foes or its prey by giving them powerful electric shocks.

### A Saw for a Snout

The sawfish looks more like the sharks than the rays, although it is related to both these tribes of fishes. It is a huge fish with a saw often quite six feet long in front of its head. This "saw" is really the snout of the fish, which is like a long, flat blade set on each side with sharp, pointed teeth, a truly fearsome weapon. Another odd connection

of both the sharks and the rays is the angel fish or monkfish. Why it is called an "angel" is a question. It certainly is not angelic either in looks or in ways! "Monk fish" is perhaps the better name of the two, as its dark, round head is not unlike a monk's hood in shape. But no matter what we call the fish, it is an ugly-looking monster four or five or occasionally ten feet long, with a long, broad, flat head and body,

two large winglike fins, and a long, thick tail. Like its cousins the rays, the angel fish is fond of lying half buried in the sand, where the mottled brown color of its back makes it almost invisible. Hidden in this way from the eyes of wandering crabs and fishes it rests quietly, waiting for its dinner. It seizes and crushes in its jaws any mollusk or crustacean that passes by, but what it really likes best is a nice plaice or a tender sole. If neither of these fishes happens to come near the angel fish, it grows impatient and stirs up the sand with its fins, uncovering numbers of small burrowing worms, who begin wriggling about in alarm. This trick at once attracts all the fishes round about to the spot. Plaice and soles come hurrying up in great excitement to this unexpected feast of worms, only to find themselves caught and crunched up by the cunning monster.

## THE STORY OF THE SEA



Painted Especially for This Work

This picture is not exaggerated, for a spearfish can drive its "spear" quite through the side of a wooden boat; and with its enormous "saw" the sawfish is said to be able to cut a man in two. When a spearfish punctures a boat in this way, it has to break off its spear before it can get

The plaice, soles, turbot, halibut, flounders and many other fishes all belong to the large company of flatfishes that live always on the sea bottom, moving slowly about or resting on the sand. It is very difficult to see them, for they mimic the ground on which they lie so wonderfully. I say "mimic" inasmuch as the fish have an extraordinary power of changing their color to suit the occasion. A flatfish on a light sandy bottom will be of a light sandy color; but if you move it to darker ground it at once begins to grow darker to match its background, and in a very short time it will have faded out of sight before your very eyes. To perform this vanishing trick successfully the fish must be able to see the ground on which it is resting; consequently it is able to twist and turn its eyes about in all directions.

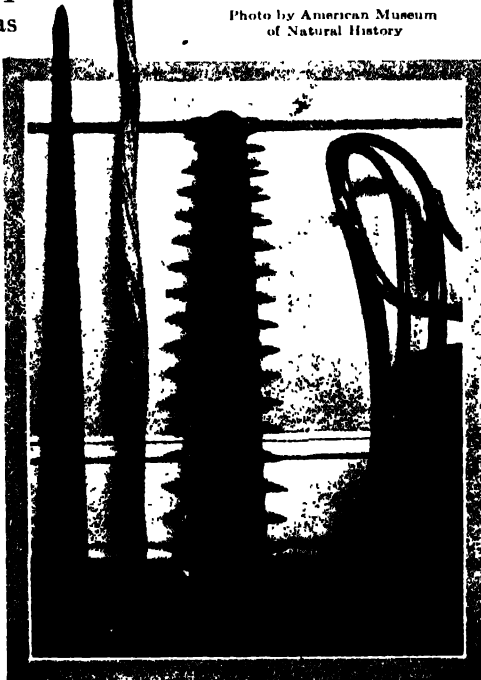
away. Of course it uses its weapon to kill or maim fishes it wants for food. The spearfish belongs to the mackerel tribe, but the sawfish is a relative of the skates and rays. With its sharp-toothed saw, which may be as much as six feet long and a foot wide at the base, it saws right and left among shoals of smaller fish. It is not uncommon for the sawfish to reach a length of twenty feet, and one captured in the West Indies weighed 5,300 pounds.

It can look up through the water, in front, behind, and on each side, and so survey the neighborhood all around. It will take on the color of whatever kind of ground it rests on, whether light, dark, or gravelly.

It is the upper side of the fish that is colored in this way. The under side is always white or very lightly tinted. Many people when they buy a sole or a plaice imagine that the dark side is the back and the light side is the stomach of the fish. But this is a mistake. True flatfishes always lie on one side. The dark, spotted side of a plaice, for example, is not the back but the right-hand side of the fish; and the pale, under surface is the left-hand side. What seems more curious still is that both eyes are on the right-hand side of the head, while the mouth is twisted round in a queer, lop-sided fashion.

This will give you an idea of the size of the strange weapons that the spearfish and the sawfish carry about with them.

Photo by American Museum of Natural History



Now when the young plaice is hatched from

## THE STORY OF THE SEA

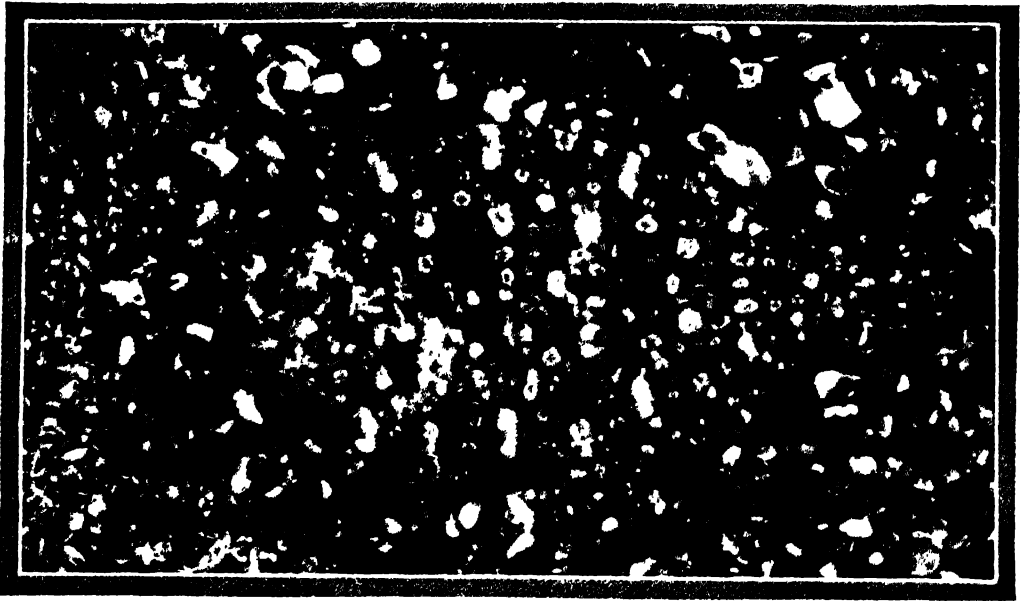


Painted Especially for This Work

Seven little fish? No, not at all! These are seven pictures of the same little fish at different stages in its growth. It begins, newly hatched, in the upper left-hand corner. It is only about an eighth of an inch long. When it is three-fifths of an inch long, it has changed its shape considerably, as shown at the right; and at the third and fourth stages it has grown still more. But it still swims upright in the water, and both of its sides are alike. At the fifth stage,

when its stripes are strongly marked, our little fish begins to change amazingly. Its left eye starts to travel up and across the top of its head. In the sixth stage the eye has traveled round still more; and now the little fish sinks to the bottom and lies on its side, of course with its eyes on top. It can no longer see on both sides when it is upright. In the seventh stage it is fully grown; its eye has traveled quite around its head. It is now a "flatfish."

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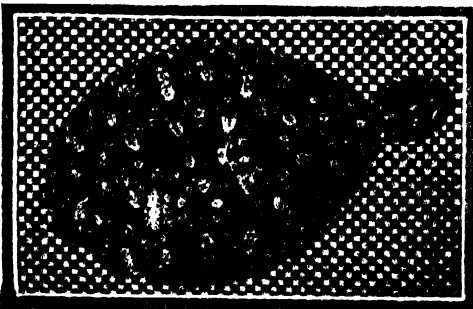


Photos on This Page by British Museum (Natural History)

**Puzzle! Find the fish!** In an instant "flatfishes" can change their appearance on the upper side in order to match the ground they are lying on. But they have

one of the many millions of eggs floating about near the top of the sea, it is not like this. There is nothing to distinguish it from other baby fishes; it is much the same shape as a newly hatched haddock, codling, or mackerel, and has one eye on each side of the head in the usual way. But soon a very strange thing happens. The left eye of the wee fish begins to move slowly round its head, and presently it travels all the way over the top and appears on the opposite side. At the same time its tiny mouth grows twisted. When it is ready to leave the sunlit surface water and settle down in life, the

**This flatfish too is doing a brand-new trick.** With practice he learned to change more rapidly to this unnatural pattern than he was able to do at first.



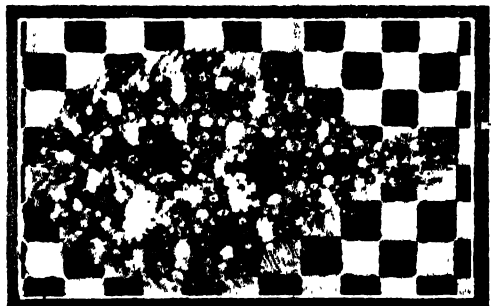
to be able to see it before they can imitate it. If you look hard you can find the outline of the "hiding" fish in the picture above. But you must look hard!

young plaice has been transformed from a wee round fish into a lopsided little flatfish just like its father and mother.

Some flatfishes lie on the left side, others always rest on the right side. The turbot, the brill, the halibut, and a few other flatfishes, although they have both eyes on the same side of the head, do not have twisted mouths.

The power of changing color to match their surroundings is of course a great protection to fishes who spend so much time lying on the sea floor. By this camouflage they often escape the sharp eyes of their natural foes.

**This flatfish is doing his best to look like a checkerboard.** He never had practice at this particular trick before, so it took him half an hour to do it.





## THE STORY OF THE SEA

Big fishes, such as the sharks, rays, and dogfish, are well able to look after themselves and hold their own against their enemies in the sea. Some rely on their strong teeth; others, like the sawfishes, the sting rays, and the swordfish, have special weapons with which they defend themselves or attack their prey. The swordfish is like a gigantic mackerel some twenty feet long, but its snout is like a long, flat, sharp-edged sword. With this fearful weapon the sea monster strikes out right and left, stunning and wounding its victims before it devours them. Its cousin the spearfish is armed with a pointed spear and pierces instead of slashing at its foes. It will dash full speed ahead at anything it takes a dislike to. One of these warlike fishes will occasionally run its spear all the way through the side of a boat—which perhaps it mistakes for a whale; but this rash action is the end of its career, for it cannot get free again.

The smaller fishes, who have no natural weapons to defend themselves with, must trust to their swiftness or to their powers of concealment to escape from their persecutors. So we find that a great many are protectively colored, or know how to make themselves inconspicuous in their native haunts. Even the gay tropical fishes, whose brilliance almost makes us blink when we see them swimming about in an aquarium, are not very noticeable when they are at home in the bright waters of the tropic seas, flitting about among bright corals,

sponges, and sea anemones. Angel fishes arrayed, like Joseph, in coats of many colors, parrot fishes and wrasses gleaming with all the tints of the rainbow, and smart little demoiselles clad in light blue, orange, and scarlet, do not appear at all overdressed or unnatural when they are at home. Many of these gay fishes, too, are able to change their coloring to suit the need of the moment. A chocolate-colored fish will suddenly blush scarlet and then fade to a pale yellow, and spots and stripes of different hues may be switched off and on in a bewildering way. But it is no use trying to describe all the bright and beautiful fishes that live in the sea garden; you must see them to believe in them.

Color changes in fishes may be due to sudden excitement or alarm or to their attempts to make themselves as much as possible like their surroundings, but in some cases they are caused by different effects of lighting. When we look down from the deck of a ship at a school of the larger flying fishes swimming in the sea, they appear to be a soft greenish-blue with pale pink "wings." Out of the water they are a bluish slate color with wine-colored "wings"; and when they skim like

a flight of swallows over the surface of the water their scales glisten in the sunshine like silver. The flight of these lovely ocean wanderers is not exactly like the flight of a bird. The graceful, winglike side fins act more as a parachute. The fishes leap from the water and with wings outstretched plane through



Photo by Government of New Zealand

This swordfish, caught off the northern coast of New Zealand, is perhaps the largest ever taken. It weighed 976 pounds. The swordfish is related to the spearfish and sailfish, and is like a very large mackerel with a long flat blade on its nose. It lives in all warm seas and gets to be nearly twenty feet long. In summer it comes up the Atlantic coast of the United States, where it is harpooned, for its flesh is a great delicacy. Like spearfish, it can attack and pierce quite through the side of a wooden boat—which it must take for some large and delicious fish.

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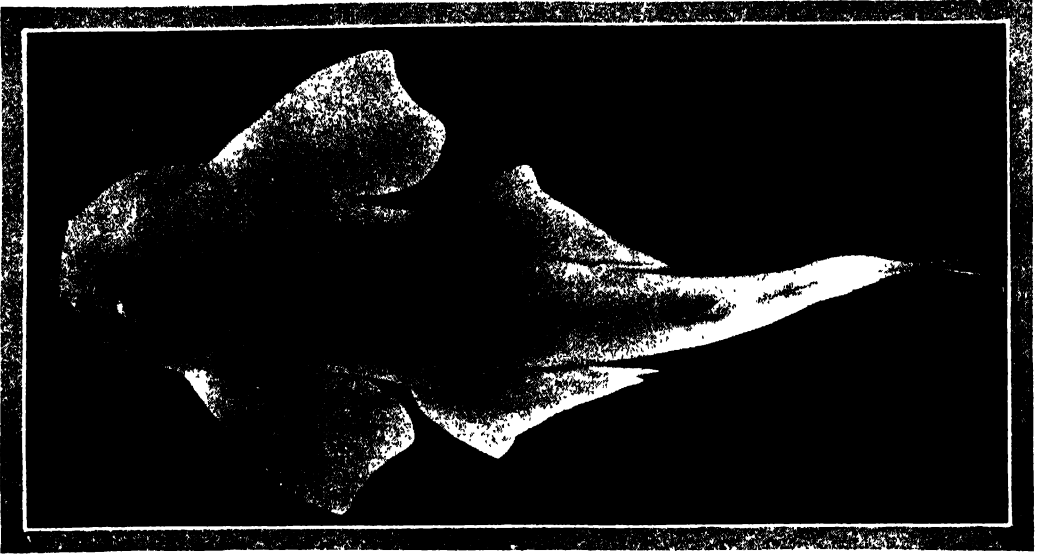


Photo by American Museum of Natural History

The strange-looking monkfish, or angel fish, is a relative of the sharks, the skates, and the rays. It propels

itself through the water by sculling with its tail. You can see why it is called the fiddler fish, too.

the air in a gliding flight for a hundred yards or so, then suddenly dip down into the blue sea again. Some of the smaller flying fishes are more like butterflies than birds. They are beautiful little things about two inches long, some with snowy fins with a black spot in the center of the hinder pair, some with brightly painted wings of many colors. Squids and big fishes pursue the schools of flying fishes and catch them when they are swimming, and sea birds are on the lookout for them when they leave the water. So what with enemies both in the sea and in the air, the lovely creatures, in spite of their accomplishments, meet with the same sad

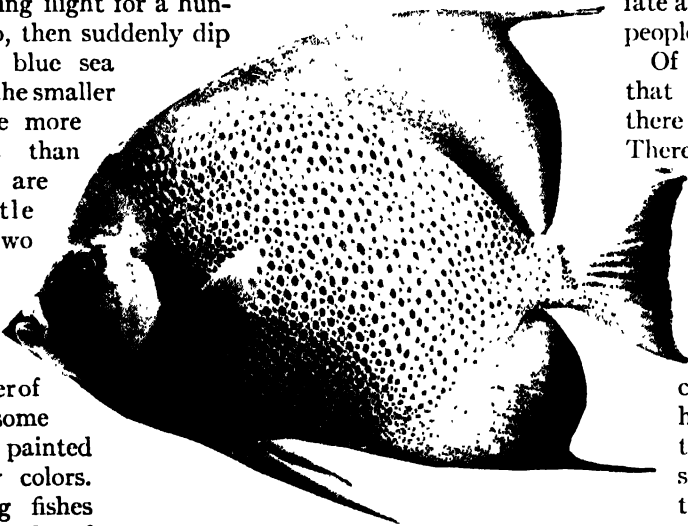


Photo by N. Y. Zoological Society

One would hardly be likely to guess that these are two views of the same creature—the bright-colored angel fish. One is taken from the side, and the other shows him from the top.

fate as other small sea people.

Of the queer fish that live in the sea there is really no end. There are the sunfishes, gigantic creatures seven or eight feet long, like "Mr. Tom Noddy, all head and no body." Of course the sunfish has a body, but the animal is so strangely shaped that it looks exactly as if it were the head of some sea monster chopped off and floating about by itself in the water.

It is balanced by two fins, one standing bolt upright behind its head and the other pointing downward beneath its chin.

## THE STORY OF THE SEA



Photo by N. Y. Zoological Society

The puffer fish, like the frog in the fable, can blow himself up with air or water until he is almost ready

to burst. The small picture shows him in his natural shape. The large one shows him inflated.

The globefishes, or "puffers," are cousins of the sunfishes, although the largest is never more than two or three feet in length and the smaller members of the family measure only a few inches. These queer fishes have the extraordinary habit of puffing themselves out with either air or water until they are blown up like balloons. The skin is stretched as tight as a drum, and all the sharp little spines with which it is covered stand stiffly out, ready to prick anyone who dares to touch the odd little fishes. This, naturally, is a most useful accomplishment, as few hungry sea creatures could manage to swallow, or even to bite, a prickly little puffer distended in this fashion. These funny little things are always playing tricks. They fill themselves with water, rise to the surface of the sea, and then squirt a stream high into the air. Or they blow themselves out with air and float upside down, as if they were dead.

### .. Left-overs from Nature's Workshop

The strange coffer fish, when you meet it head on swimming slowly through the shallow waters of the tropic seas, looks like a weird painted mask that might be worn by a medicine man belonging to some savage tribe. The cowfish has on its head two long

spines, like a pair of horns, that make it look absurdly like a solemn-faced cow. Then there are the frogfishes and sea toads—ugly fishes, these misshapen dwarfs—things with fins like arms, each arm complete with hands and numerous fingers. The fingers are really the fin rays, and help the odd fishes to crawl about or hang to seaweeds. Sea toads haunt the coral reefs, where they lie in wait and angle for little fishes. Frogfishes often live on masses of floating weed and pounce on small fishes, crabs, and cuttlefish, like the horrid little ogres that they are.

### When a Fish Goes Fishing

But worse still are the sea anglers, or sea devils, a large tribe of fishes with enormous flat heads and such huge, gaping mouths that they can swallow fishes twice their own length. Sea anglers are mostly dwellers in deep water. Some of them are four or five feet long, others are quite small. They are all clumsy things and cannot swim very well. But they do not mind this; they merely lie flat among the seaweed-covered rocks, where they are well hidden, open their huge mouth traps, and wait for a fish to come along. Their jaws are armed with long, fanglike teeth that can be folded back to hide them from view; but they stand up in a flash

## THE STORY OF THE SEA

to imprison any unwary victim who has blundered into the awful trap.

To attract fishes and induce them to "step into its parlor" the sea devil dangles a bait in front of its gaping jaws. From the tip of its nose a long, flexible bone juts out, like a fishing rod; a loose strip of skin dangles from the end of it. The fishes, thinking this is a wriggling worm, rush up to snap at it, with the result that they themselves are snapped up by the

to guide them on their way, help them to catch their food, and perhaps to enable them to recognize one another. Lovely little lantern fishes no bigger than minnows go about in the surface waters of the Atlantic and Pacific oceans fairly ablaze at night with luminescent headlights, tail lights, and rows of lights that stream from "portholes" arranged along their sides.

When there are such vast armies of fishes, as well as hosts of other hungry creatures, it seems amazing that there should be enough food in the sea to feed them all. Some, to be sure, are content to nibble seaweed or sea grasses, or to graze on living corals; but the majority of the fishes are flesh-eating, and solve the great food problem by eating one another!

Big fish eat little fish,  
and the smaller fishes get  
even by eating  
the eggs and the

Photo by American  
Museum of Natural  
History

This clownish fellow would seem to have forgotten his head and tail. In fact he is so strange as to be hard to believe. Sometimes he measures as much as eight feet from fin tip to fin tip. Round-tailed sunfish, like this one, may weigh more than a ton, but are worthless for food. In color they are bluish gray, and underneath the skin is a hard, gristly layer two or three inches thick that protects the sluggish fish from its foes.

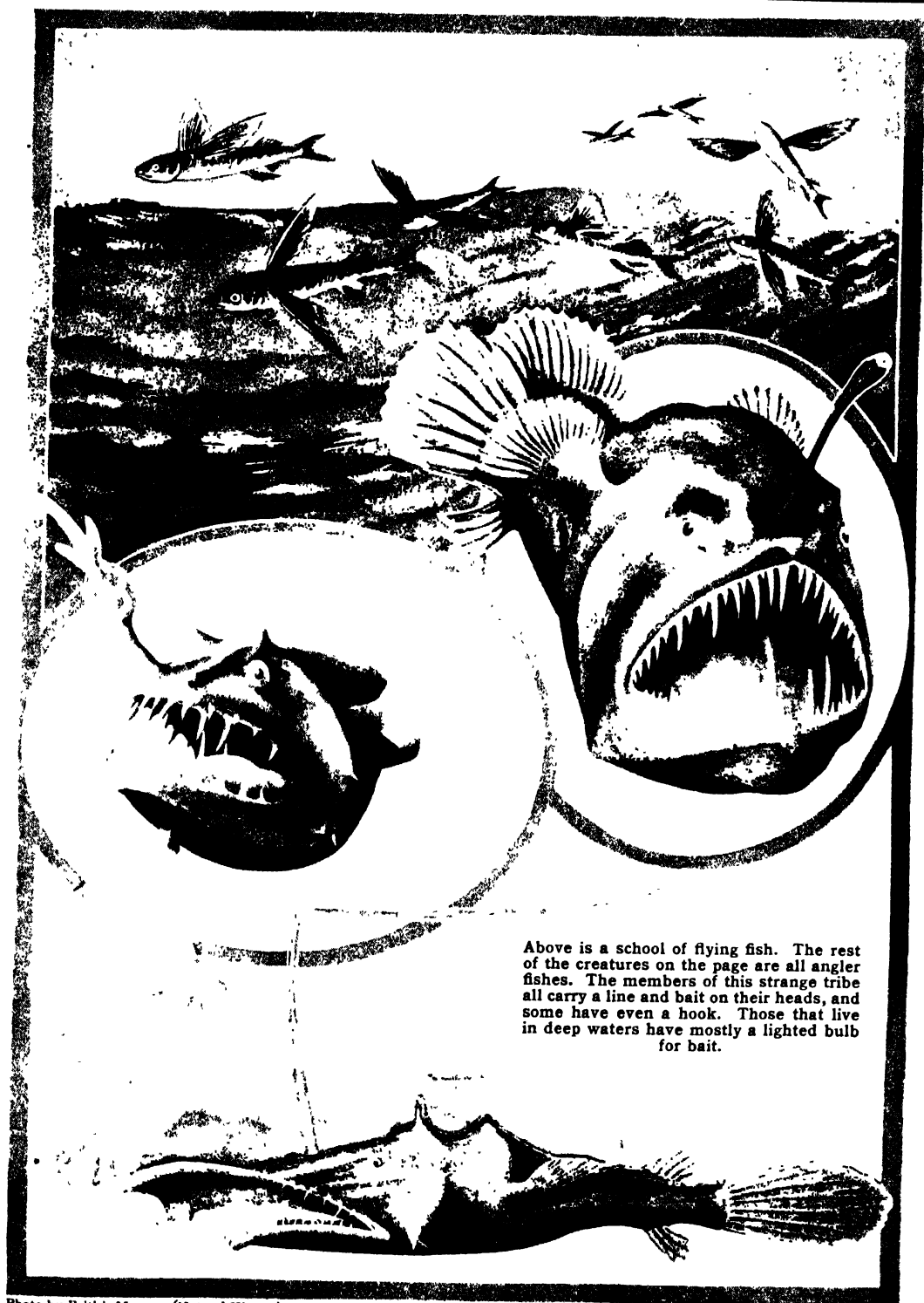
cunning sea devil. Sea anglers living in the sunless depths of the ocean actually have a light-giving bulb fixed to the end of their fishing rods. This shines in the darkness to lure their prey. Among these strange fishes who live so far beneath the surface of the sea that no stray gleam of light can filter through, there are many who carry lanterns

newly hatched offspring of many of the larger ones, as well as the eggs and young of crustaceans and mollusks, and the countless worms of the sea.

This is the chief reason why fishes and other sea creatures have such large families. A turbot may produce nine million eggs in a season and the cod-fish about five million; but the chances are that only one turbot in nine million and one codling in five million will ever live to be full-grown. All the rest of their brothers and sisters will be eaten as eggs or devoured when they are young things.

Most fishes take no trouble at all about their young ones. Their eggs are usually broadcast into the sea, where they float about on the surface until they hatch or are gobbled up. But there are exceptions to this rule. Some fishes are very good parents, and others at least provide some kind of

## THE STORY OF THE SEA



Above is a school of flying fish. The rest of the creatures on the page are all angler fishes. The members of this strange tribe all carry a line and bait on their heads, and some have even a hook. Those that live in deep waters have mostly a lighted bulb for bait.

Photo by British Museum (Natural History)

## THE STORY OF THE SEA



Painted Especially for This Work

The two fish in the center are the strange four-eyed fish that have their eyes divided in two by a dark line across the center. The upper eye is adapted to seeing in air and the lower to seeing under water. So when the fish swims along the surface of the water, as is his habit, he can see the insects above in the air, as well as any juicy morsels in the depths below. The two little fish at each end are three-spined sticklebacks.

The sharp spines on the back are terrible weapons in combat. In the nest is the father, guarding the eggs. He has made the neat little house himself and will not go far away from it until the young are hatched. When they are out of their eggs, he will tear down the upper part of the nest to make it into a cradle for the babies, whom he will continue to watch over till they are old enough to look out for themselves.

protection for their eggs, in order that they may have a fair chance of hatching. Skates and dogfishes enclose their eggs in tough, horny cases. These are the "pixy purses" or "mermaids' purses" we so often find washed up on the shore after the young fishes have escaped from them. The skate's purse is almost square and has four little horns, one at each corner. The mother skate, having deposited it on the floor of the sea, feels she has done her duty and leaves it to its fate. The dogfish's purse is longer and nar-



Photo by American Museum of Natural History

Here is a deep-sea fish all lighted up and going after its prey. Sometimes such "wide mouths" can eat fish three times their own length and many times their own weight.

rower and has long coiling tendrils at the four corners instead of horns. The tendrils are wound round about the fronds of seaweed in the great forests of tangled weed that often fringe the shore below low-water mark. In this strong little cradle the baby fish is rocked by the waves until it is ready to push its way out into the sea through a slit that opens at one end of the purse.

The little gobies do better than this.

The father and mother goby together seek for a clean, empty shell to serve as a nursery for their little family. A

## THE STORY OF THE SEA

clam shell turned upside down on the sea floor suits them, if they can find one. After hovering round it and examining it from all sides to see if it will do, the father carefully scoops away the sand from underneath it. The

leave them immediately; for a day or two the proud father may be seen with a string of baby fishes swimming after him like a brood of chicks following a mother hen.

The butterfish takes a great deal of trouble to ensure the safety of its eggs. It is a quaint little fish with a round, bullet-shaped head, and a slippery, eel-shaped body very much flat-

The sculpin at the left looks as if he had been got up for a circus. He is related to the gurnards, who walk along the ocean floor.

Photos by N. Y. Zoological Society



At the right is the useful cod. Its flesh is salted in large quantities, and the liver gives us oil that we take for its vitamins.

mother then enters the nursery and glues her eggs securely to the inside of the shell. This task accomplished, she considers she has done her share of the work; so off she goes, leaving her little mate in charge. The father is an anxious nurse; he mounts guard over the eggs until they are hatched, keeping a constant supply of fresh water moving through his nursery by vigorously fanning his little fins. He darts like a tiny fury at any creature who dares to approach his precious charges.

### A Henpecked Husband

The fifteen-spined stickleback makes a wonderful little nest of odds and ends of soft seaweed bound together with a kind of glue. Again it is the father fish who does the lion's share of the work. He builds the nest, and remains on guard after the female stickleback has deposited her eggs inside it and taken her departure. Even after the young sticklebacks are hatched, he does not

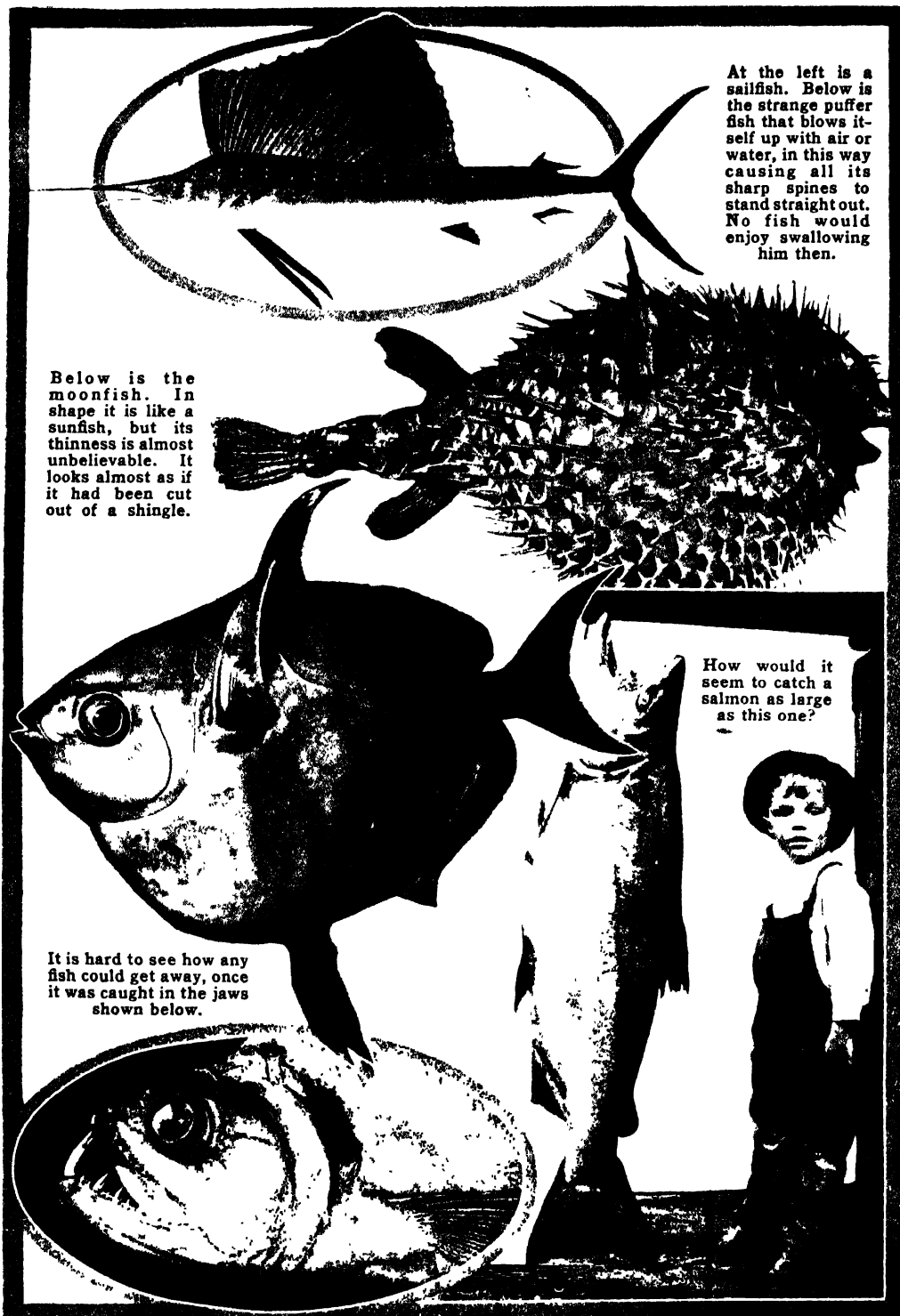


The little fellow at the right is neither a toy nor a chess man, but a curious fish that we call the sea horse.

tened towards the tail. The male and female butterfish both share in the task of guarding the eggs. They roll them up into a compact, round ball by coiling their long bodies around them, taking turn and turn about in keeping them safe. A short time before the eggs are ready to hatch, the little pair push their egg ball into a small hole in a rock or a stone, ramming it firmly in with their hard, round heads. They then swim about nearby, ready



## THE STORY OF THE SEA



At the left is a sailfish. Below is the strange puffer fish that blows itself up with air or water, in this way causing all its sharp spines to stand straight out. No fish would enjoy swallowing him then.

Below is the moonfish. In shape it is like a sunfish, but its thinness is almost unbelievable. It looks almost as if it had been cut out of a shingle.

How would it seem to catch a salmon as large as this one?

It is hard to see how any fish could get away, once it was caught in the jaws shown below.



## THE STORY OF THE SEA



Above is a tarpon, hooked. It is a favorite game fish and may measure six or eight feet. Its big scales are sometimes four inches across, and are used for ornamental purposes. It leaps high in the air when caught and taxes an angler's skill and patience.

It is only in dreams that most of us haul up our fish with a derrick.

This gray old fisherman knows all the whims of finny folk.

## THE STORY OF THE SEA

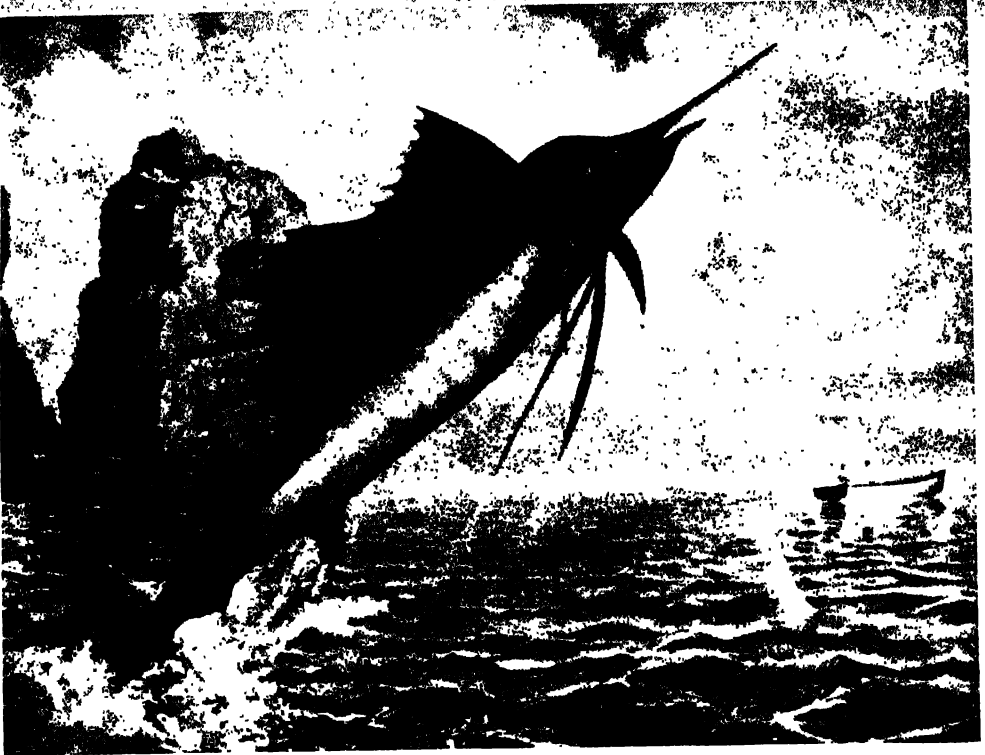


Photo by American Museum of Natural History

Will they get him to the boat? This sailfish looks almost big enough to set sail and steam away, towing the boat behind him. Sailfish may grow nearly twenty feet long, but they never use their "sails" for anything but swimming. They are dangerous things to catch,

to attack any other fish who attempts to interfere with their property, and do not relax their vigilance until the baby butterfly-fish come out and swim away.

### The Amusing Lumpfishes

Other fishes of different kinds fasten their eggs under rocks and stones, sometimes leaving them to their fate, sometimes remaining on guard until the young ones are hatched. The funny old lumpfishes, which live in deep water, clinging fast to rocks or stones with their curious suckers, come up to the weedy shallows in the springtime to deposit their eggs for safety in some rocky crevice. Then, as so often is the way in fish society, the lady lumpfishes go off to enjoy themselves while the father fishes stay behind to keep watch and ward.

More devoted still are the father pipe-

fishes, for if they are hooked or speared, they leap about violently and may run their "spear" quite through the side of the boat. On calm days they often lie on the surface of the water. Then their bright blue "sails" are very beautiful, flashing in the sunlight.

fishes, for they actually carry the eggs about with them in a special waistcoat pocket and even nurse the babies after they are hatched. There are several kinds of these curious fishes living among the weeds and grasses round about the coasts in most parts of the world, strange, long, stiff creatures, so like blades of grass in shape and color that it is quite difficult to tell which is which.

### They Can Swim Head Down

Pipefishes are feeble, harmless folk. Intent on catching tiny shrimps and other small crustaceans, they move slowly through the water by wriggling their long bodies and going through all sorts of strange contortions. Sometimes they swim perpendicularly—head up or head down, it does not matter which—and sometimes in a more or less horizontal position. They have a long, tubelike snout

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## THE STORY OF THE SEA

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Painted Especially for This Work

*Not only does Mother Nature give her children of the deep more brilliant colors than she gives those of the air, but she also makes them in every sort of queer shape. And no matter what she does, she always has*

*the same end in view: to help her creatures escape from their enemies and get plenty of good food. In the picture above is every sort of arrangement of body and tail and fin—and all of them useful.*



## THE STORY OF THE SEA

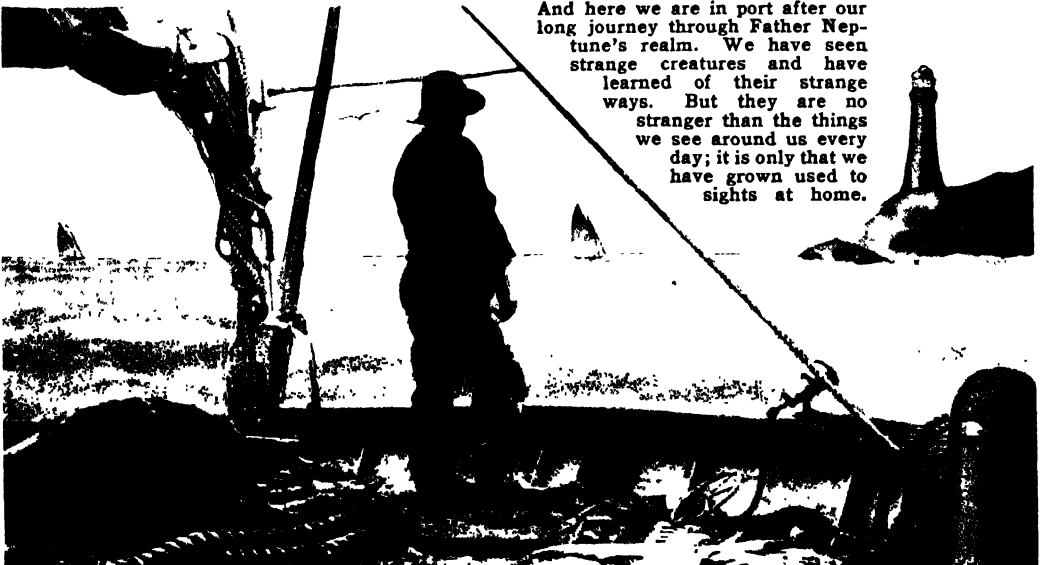
with a small round mouth at the end of it, and suck in their food in much the same way as water is drawn into a syringe.

The brood pouch is formed by two little flaps of skin which are folded over the eggs. When the male pipefish has tucked the eggs in carefully, he carries them about with him wherever he goes. When they hatch, the wee fishes do not at once leave their kind parent; they stay quietly in his pocket until they have grown a little older and stronger. Then the careful father opens his waistcoat and the youngsters pop out into the sea. But at first the baby fishes do not go far away. They are timid little things and if anything frightens them they creep back under father's waistcoat, just as young kangaroos take shelter in their mother's pouch.

The little sea horses take care of their children in the same way; and again it is father who has the brood pouch and acts as nurse to the little ones. A sea horse is an exceedingly odd little fish. It has a horse's head and is clad from the tip of its snout to the tip of its tail in stiff plated armor. It is exactly like the knight in a set of chessmen. But instead of being fastened to a little round stand, it has a long, dragon's tail that is always coiled round one thing or another, such as a frond of seaweed, a splinter of wood, or even another sea horse. Sometimes half a dozen or so of these queer little fishes

will float about the sea in a friendly way with all their tails entwined together. When tired of one another's company, they disentangle their tails, with a good deal of wriggling, and one after another move slowly and solemnly off on their own affairs. They swim bolt upright, progressing slowly through the water by rapidly vibrating their small fan-like fins. But they do not move very fast this way, and much prefer to anchor themselves by their tails to pieces of floating weed or wood and allow themselves to be carried along by the currents.

And now while the little sea horses drift away on a voyage of adventure, we must climb back to dry land and our own everyday world again. We have wandered together for a time in the kingdom of the sea, have met with some of the sea people, and have learned a little—but only a very little—about their ways and the strange things there are in the blue water world. The sea is so wide and so deep and so full of marvelous things that no one knows all that goes on beneath the waves—and no one ever will. And this is really a comforting thought, for the world would be a very dull place if there were nothing left to discover, wouldn't it? Happily there are, and always will be, any number of new things to learn. Who knows what even you or I may find out for ourselves some day?



And here we are in port after our long journey through Father Neptune's realm. We have seen strange creatures and have learned of their strange ways. But they are no stranger than the things we see around us every day; it is only that we have grown used to sights at home.

# ***The STORY of LIFE in the SEA***

## **Reading Unit No. 15**

### **A TRIP TO THE AQUARIUM**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

What an aquarium is, 3-217  
How salt water is brought to an aquarium, 3-217-18  
How aquarium water is kept

clear and fresh, 3-218  
Mealtime at the aquarium, 3-219  
What to see at the aquarium, 3-219-20

#### ***Things to Think About***

Why is running an aquarium very expensive?  
How is aquarium water purified?  
How is the water supplied with

oxygen?  
How are aquarium fishes fed?  
How does the aquarium provide natural conditions for the fish?

#### ***Picture Hunt***

What do aquarium collectors look for when they select specimens for exhibition? 3-217  
How is the lungfish shipped to the aquarium? 3-218

Does each aquarium tank contain only one kind of fish? Why? 3-219  
What is done when a fish falls ill? 3-220

#### ***Related Material***

How should you treat a sick aquarium fish? 14-5  
How can we learn interesting

facts about fresh-water life? 3-226, 235, 244, 254

#### ***Leisure-time Activities***

PROJECT NO. 1: Visit an aquarium and take a notebook with you.  
PROJECT NO. 2: Set up and

maintain an aquarium with live fish, 14-2-5  
PROJECT NO. 3: Learn the story of life in the sea, 3-71-216

#### ***Summary Statement***

A large aquarium provides natural conditions so that people can see at first hand some of the wonderful animals that live

in fresh and sea water. No one who can do so should fail to visit a large aquarium, like the one on Catalina Island in California.

## THE STORY OF THE SEA



Photo by N. Y. Zoological Society

Here is a new kind of fisherman. He does not play the stout trout on the end of his line for the sport of it; nor does he ensnare tons of halibut or cod in a trawling net for the market. Instead he seeks out the

oddest and most beautiful of the water creatures to show to the rest of us. In this picture an expedition sent out by the New York Zoological Society is collecting specimens for an aquarium.

### A TRIP to the AQUARIUM

*Above All Other Places, This Is the One Where We May See the Strangest Creatures and the Brightest Colors That Nature Has to Show*

**M**OTHER NATURE has given more brilliant colors to her children that live in the sea than to any other creatures. It is not the birds that wear the gayest clothes. If you could see through the water as clearly as through the air you would know that there are thousands of fish as brilliant as jewels. And many of them are very queer besides.

Now very few of us will ever have a chance to put on a diver's dress and visit the depths of the ocean, but in a good many places the ocean's depths have been brought ashore to us. In the great public aquariums of cities like London or Naples or various large seaside towns one may stand in front of the big glass tanks and watch the doings of many strange and beautiful creatures that usually live well out of sight of man. Here they have been gathered from the ends of the earth—ferocious sharks and

little rainbow-tinted fellows that dart about among the coral caves, strange creatures no thicker than cardboard and others that can blow themselves up as round as a balloon, fishes that lie flat on the ocean bottom and so have both eyes on one side of their heads, and all sorts of timid fellows that have put on a stout armor to protect their tender bodies. The water sparkles crystal clear, and a soft light illumines the sandy floor and rocky background of the tanks, against which the fishes gleam. It looks like fairyland.

It is in London that we shall find the newest and the best-equipped of the big inland aquariums. Cities that are on the sea, as Naples is, have a problem that is fairly simple. But inland cities like London must bring the sea water a good many miles. How is it done?

All the salt water in the London Aquarium is brought up the Thames from the Atlantic

## THE STORY OF THE SEA

in the ballast tanks of steamers. At the London docks it is discharged into barges that carry it up the Regent's Canal to the Zoological Gardens, at Regent's Park. Then through long hose it is pumped into a great 120,000-gallon reservoir under the Aquarium.

Now, as you may see, this is a pretty expensive business—far too costly to make it wise to use any more water than is absolutely necessary. So the same water is used over and over again. Only about twice a year are a few thousand gallons added to make up for what has leaked away or been lost in other ways.

But what is this, you say—the same old water is used year after year after year? Yes, and see how bright and sparkling it is. No brook was ever clearer.

Now the secret of it all is simple enough, once you understand it. In the first place, the water is always kept in circulation. From the tanks where the fish are kept it passes down through overflow pipes to a series of filter beds, where all the impurities are removed. Then it goes to a great deep-level reservoir that is under the floor of the Aquarium. About half the whole supply is always lying there in pitch dark, for that has proved to be a simple but effective way to kill certain very tiny organisms that

may remain in impure water even after it has been passed through the filter beds.

When this process of filtering and dark storage has once more made the water fit for use, it is pumped into the supply tanks that are high up on the roof of the Aquarium.

From them it flows down, by its own weight, through supply pipes into the exhibition tanks. And in

due course it will again begin its round when it once more finds its way into the filter beds and the dark storage reservoir. The fresh water in which the lake and river fishes are kept goes through the same process; so you see, all the water in the Aquarium is kept in constant motion.

Besides this, it is constantly receiving a fresh supply of oxygen as it passes through the exhibition tanks. This is absolutely necessary, for the fish breathe oxygen out of the water through their gills just as we breathe it out of the air through our lungs. They would

soon die without it. But because they are constantly taking it out of the water, it must constantly be put back in again. So if you look carefully you will see that somewhere in every tank, a steady stream of glittering bubbles of air is rising through the water. Day and night, from year's end to year's end, automatic electric pumps are at work pumping air into the tanks.

Since we are making our tour of inspection without ever leaving our own fireside, we



Photo by American Museum of Natural History

It would be hard to find a queerer creature than the lungfish, which comes from the Nile and Congo rivers. In flood season it swims about like any other fish. But when the water gets low in the dry season, it burrows into the mud, as in the oval above, and spins itself a cocoon like a caterpillar. It has a little tube to let in the air—for besides having gills for breathing under water, it also has lungs to breathe in air! While the lungfish lies curled up sleeping, we sometimes take it up in its great cake of mud and carry it off to some aquarium. Then we crack the cake open, as above—and there is the funny fish, ready to come to life and swim about as lively as ever.



## THE STORY OF THE SEA

may as well consider ourselves privileged visitors and go behind the scenes—something we surely would none of us have the ill manners to attempt if we were making the visit in body. What a surprise! Here, back of the tanks, is a service gallery built flush with the top of the exhibition tanks. From it the keepers can look down into the tanks

people are—and with a great deal more excuse!

Every tank is planned to make its special occupants feel as much at home as possible. Here is the one where the sole and plaice and turbot and rays try to act as if they were in the depths of the sea. At first glance you might take the tank to be empty.



Photo by N. Y. Zoological Society

Here is one of the glass cases in one of the world's big "fish zoos"—that is, one of the tanks in an aquarium. The fishes that live in it are not all alike, as we can see. Indeed, many of the tanks contain creatures

which are not fish at all, though they live in the water. The best aquaria show us nearly all the plants and animals of lake, stream, and ocean—all, that is, which can live in the shallow water of their new homes.

without ever being seen in the public hall. Here too are the tanks in which the new arrivals are kept under observation for a few days, so that there may be no doubt that they are sound and healthy when they are put into the exhibition tanks.

### The First Call for Dinner

Once a day a keeper passes around the exhibition gallery with a bucket of shrimps, small pieces of chopped fish, and other food with which to feed the inhabitants of the tanks. Then it is very funny to watch the excited fishes. They dash upward and dart wildly about in their eagerness to snap up every dainty morsel before it can sink to the floor of the tank and be grabbed up by the crabs and lobsters that live there. For fish are just as greedy as a good many

The floor is covered with a thick layer of sand in which the plaice delight to lie buried, with just their heads and queer goggly eyes showing. But every now and then one will shake off the sand and take himself for a swim; and then you can see the great flat fellow whose two eyes are on the same side of his head—the side that always lies uppermost. And then, too, you can see that his upper side is drab to match the sand, but his under side pure white, for it is always hidden.

Here is a tank that looks like a tiny flower garden. It is the home of the gay sea anemones, which attach themselves to rocks or half bury themselves in the sand. On the top of their thick "stems" is a waving circle of tentacles that look a good deal like the petals of a cactus dahlia. In the center of

## THE STORY OF THE SEA



Photo by N. Y. Zoological Society

Bruises, a variety of internal disorders, and other ills receive treatment in this well-equipped laboratory

in a famous aquarium. To this impressive hospital any ailing fish is brought for treatment.

the "flower" is the queer creature's mouth, and many are the little shrimps and prawns, the baby crabs and tiny fishes that are seized by those active "petals" and crammed into the animal's mouth. Here in the Aquarium these strange sea flowers are fed on shrimps and small cubes of fresh fish. It is in this tank that we shall see, too, the queer old hermit crab that tucks his sausage-shaped tail into a large whelk shell, which he carts about with him and uses as a portable house.

In still other tanks are the beautiful starfish, or those armored knights of the sea, the crabs and lobsters and crawfish. Many are handsomely colored and very graceful.

But we must not stay here too long, for we still have the fascinating tanks full of fresh water, where we may visit our more familiar friends of lake and river and brook—the beautiful rainbow trout, the gloomy pike, and other graceful creatures that we like to see lying on our plates at dinner.

No fresh-water tank is more beautiful than the one that holds the little fish from the Tropics. They are like exquisite butterflies. Although most of them are quite

small in size, ranging from barely an inch to eight or ten inches in length, their scales are so brilliant with scarlet, azure, blue, purple, green, and gold that they are almost dazzling as they dart about in the water flicking their tiny tails.

In our delight at watching their movements we must not pass by the tank that holds the sober newts and water beetles, for they are quite as interesting in their way. Here is the water spider, with her beautiful nest like a diving bell, and here are the staid old pond snails and mussels, living in the midst of delicate water plants that shelter tiny carp and brilliant little goldfish.

You may very well find this tank the most interesting of all, for these are the very beasties that you can keep in your own little aquarium at home. Elsewhere in these books we have told you how to prepare and care for one. It gives very little trouble, and is as beautiful to see as it is amusing to watch. Indeed, it was by keeping little aquariums at home that scientists learned how to run big public aquariums like the one we have just been describing.

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# ***The* STORY of FRESH-WATER LIFE**

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## **Reading Unit No. 1**

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### **THE FRESH-WATER WORLD AND ITS FOLK**

*Note: For basic information not found on this page, consult the general Index, Vol 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

How streams, brooks, and rivers hide many interesting creatures, 3-222  
Where otters live, 3-222  
How otters earn a living, 3-223  
How beavers make their houses, 3-223

Fish life in streams and brooks, 3-224  
Crawling things to be found in streams, 3-224  
The wet nursery for young insects, 3-224

#### ***Things to Think About***

Where does the water of streams, brooks, and rivers finally go?  
Why do otters live near water?  
Why are beavers always busy?  
How can beavers keep water from draining away and leaving their

houses on dry land?  
What kinds of animals are we most likely to find in streams and brooks?  
Where do many insects spend their babyhood?

#### ***Picture Hunt***

To whom must we go for information about the life of fishes? 3-222  
What special adaptations to water

life do muskrats have? 3-223  
Where does an otter eat the fish it catches? 3-224

#### ***Related Material***

Besides fishes, what animals may be found in a stream? 3-254-62  
What are the daily habits of

beavers? 4-373-76  
How does an otter catch fish? 4-361-62

#### ***Summary Statement***

One usually thinks of streams as consisting only of running water. But the student of nature who investigates the life in streams soon learns that there are many interesting plants and animals there. Insects, young or fully grown, crawl or dive or swim

to get food or to escape from enemies. Many kinds of fish dart here and there. In large streams we may find a beaver lodge or a muskrat home. If we are lucky we may see an otter dive for a fish.

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## LIFE IN OUR STREAMS AND BROOKS



It is April, and this little woodland pool is busy with life. If you look closely you will find three frogs close at hand and half a dozen salamanders, while at the pool's farther side a school of tadpoles goes whirling by. Besides these, there are masses of toads' and frogs' eggs.

Photo by  
Natural History, New York

### *The FRESH-WATER WORLD and ITS FOLK*

#### *The Placid Stream and Little Brook Are the Scenes of a Fascinating and Varied Life*

**T**HE scene of our story is a strip of ground only a few feet wide but many miles in length. One end of it lies in the heart of the great mountains, where a tiny stream of water, crystal clear, comes bubbling out from the mountain's side. Purling and sparkling it plays hide-and-seek in and out of the rocky channel, tumbles helter-skelter over rocks and boulders, dances gayly over the stones, and twisting, turning, now right, now left, hurries down to the valley below. There it wanders through flowery meadows, slips under bridges, plunges over rocky ledges, and washes villages and towns. At last it reaches the goal it has been seeking all along. It joins the broad river; and in company with many another rippling brook and mountain stream it flows steadily on to the sea.

What curious secrets it must have seen of all the strange water folk who live by it and on it and in it! For every little brook and rivulet, every wide stream and mighty

river is the home of countless interesting and entertaining creatures. Every tranquil lake and pool is a bewitching water world where hosts of surprising little beings dwell, and where the most astonishing things are always going on.

Along the banks of British streams and rivers, close to the water's edge, whole colonies of cunning little water voles, near relatives to the rat, tunnel out their underground homes. We may catch a glimpse of one of the independent little animals late in the afternoon. He is peering cautiously out of his front door, eyes shining, whiskers twitching, as he glances quickly up and down the stream before he slips with a plop into the water. Then away he goes like a silver streak, his coat glistening with the tiny air bubbles entangled in his soft, close fur.

A much larger hole, well hidden among the twisted roots of an old tree growing on the banks of the stream, may be the home of an otter and his little family. The otter seldom

## LIFE IN OUR STREAMS AND BROOKS

leaves his shelter until nightfall, but you may see his footprints in the mud all round about; and perhaps you may find a slippery slide down the bank, where the big and little otters amuse themselves by tobogganing into the water one after another. They love this game so much that they will scramble up the bank and slide down again time after time just for the fun of the thing.

Otters are the most light-hearted of animals. It makes one laugh to see the way they frisk and gambol in the water when they come out at night to feed and play. But most of all they enjoy fishing; though since they kill far more fish than they can eat, otters are often rather a nuisance in the streams and rivers where they live.

### The Serious-minded Beaver

Now the beaver, one of the most interesting water animals, is very different in his ways. He is a serious-minded person and prefers work to play any day of the week. He likes comfort too. His house, which may still be seen on the banks of many rivers in North America, is a large, solid, well-built affair. No hole or corner for him!

The beaver's work is never done. He is always busy changing or improving his "lodge"—as his house is called—in one way or another. He piles more sticks on the roof of the house and plasters a thick layer of mud on the top. He enlarges his living room, and is continually tidying it up or carrying in fresh litter for his bed—there is no end to the tasks this industrious animal sets himself to do.

He takes liberties with the river, too. If the stream is not wide enough and deep enough to suit him, he builds a barrier of logs and stones, of mud and moss right across it from

bank to bank. This makes a dam to hold the water back and prevent his house from ever being left high and dry, even in times of drought. For there is nothing a beaver dislikes so much as that.

### Dabbling Ducks

On the brook's surface, among the reeds and rushes, water birds of many kinds swim about and have a most delightful time gobbling up the polliwogs and other good things in the stream.

"All along the backwater,  
Through the rushes tall,  
Ducks are a-dabbling,  
Up tails all!"

Down go their heads and up go their tails in a comical way, as ducks and ducklings scoop in the mud or tug at the roots of the water weeds with their broad yellow bills.

Among the tall rushes shy water hens, too, make their nests, and when their precious eggs are hatched, come proudly forth to introduce their little broods to the water world. The young chicks soon grow water-wise. They learn to swim and dive, to snap up the polliwogs and water insects, and to dip down under water or hide among the rushes without a moment's delay when they hear their mother's low, warning "croo-croo!"

But it is *in* the water that we shall find most to interest us. For the water is always full of life. Look down into the stream and you may see all

The little animal on the left is a European water shrew, and the larger one on the right is a muskrat. Both of them have webbed feet and swim and dive as though they were born in the water instead of on the bank. Naturally they are much feared by all the small fishes.

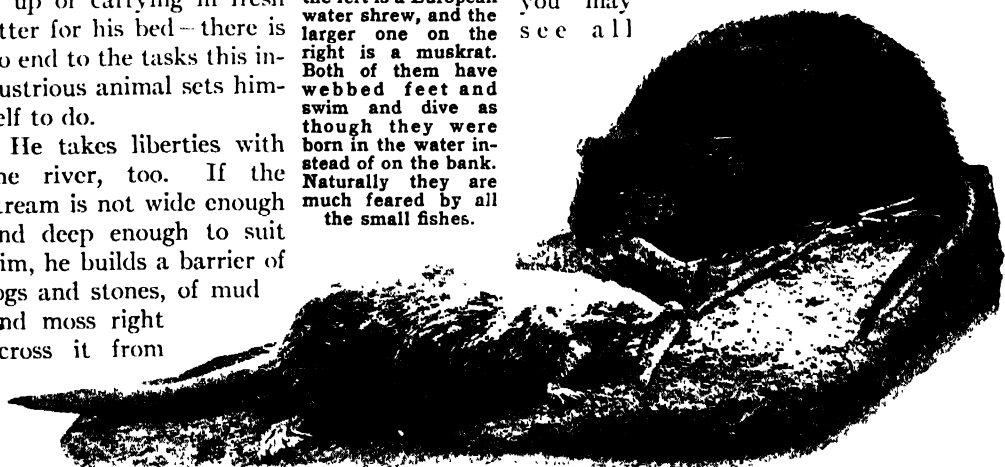


Photo by American Museum of Natural History

## LIFE IN OUR STREAMS AND BROOKS

the weeds, and in the mud or sand at the bottom, a whole host of queer little folk are hidden away.

First, and most important, are the fish folk—the big fish and little fish that haunt every flowing river and rippling brook, every shining lake and pool all up and down the countryside. Watch them, as they glide through the clear water as lightly and easily as a bird flies through the air. They are

The rest of the water population is made up of a medley of little creatures, some ugly, some beautiful, some strong and fierce, some weak and timid, but all interesting

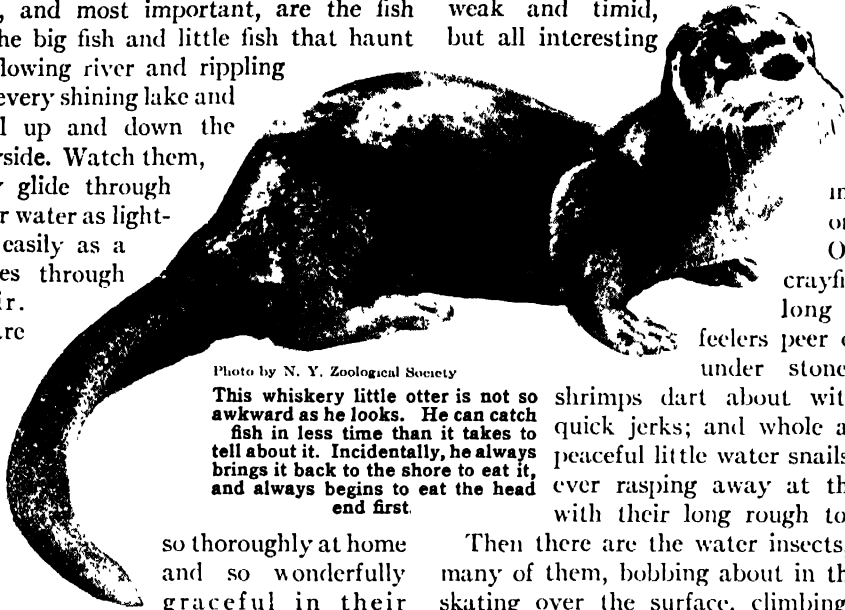


Photo by N. Y. Zoological Society

This whiskery little otter is not so awkward as he looks. He can catch fish in less time than it takes to tell about it. Incidentally, he always brings it back to the shore to eat it, and always begins to eat the head end first.

so thoroughly at home and so wonderfully graceful in their movements that it is a joy to see them.

You may think, perhaps, that all fishes are much alike, and that there cannot be much to say about them. But this is a mistake. Fishes have different ways and different characters just as birds and land animals have, and it is surprising what curious things some of them do. There are timid fishes who spend their days lurking in the shadows or lying at the bottom of a deep, dark pool; and there are fierce, bold buccaneers who roam about chasing and killing smaller fishes and other unhappy little water folk. There are slow-going, stay-at-home fishes who are content to stay all the year round in the same place and never wander far up or down the stream; and there are restless, adventurous fishes who love change of scene and are always traveling about. There are careless fishes, who do not care a bit what happens to their children; and there are others who build neat little nests and bravely protect their eggs against the attacks of greedy water creatures. No indeed, fishes are by no means all alike, and the chattering brook has many a tale to tell of how they live and what they do.

in one way or another. Odd little crayfish with long twirling feelers peer out from under stones; fairy shrimps dart about with funny quick jerks; and whole armies of peaceful little water snails are forever rasping away at the weeds with their long rough tongues.

Then there are the water insects, ever so many of them, bobbing about in the water, skating over the surface, climbing up the weeds, or crawling round in the mud. Extraordinary sausage-shaped creatures with great hooked jaws, and others like cigars with spindling legs roll and tumble and fight together on the floor of the stream; and tiny bundles that seem to be made of snips of leaves and bits of straw appear suddenly to come to life and march along all by themselves.

Many of these peculiar creatures live the strangest of lives and, after going through the most surprising changes, are transformed from ugly grubs into bright winged insects that rise from the water and fly up into the sunny air—for the rippling stream is a nursery for many odd creatures besides the tadpoles that turn into frogs and toads.

The water world is as full of wonders as a fairy-tale book. There will always be something to amuse or interest us when we peep into it. Let us follow the stream, listen to the tales it has to tell, and learn something of the ways of the little water folk. The few short hours we shall spend in making their acquaintance will add immeasurably to the pleasure of our waterside rambles through all the years to come.

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# ***The* STORY of FRESH-WATER LIFE**

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## **Reading Unit No. 2**

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### **OUR FINNY FRIENDS OF THE BROOK**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

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The ways of the sunfishes, 3-228  
The strange courtship of the  
stickleback, 3-229  
How Father Stickleback looks

after his family, 3-230  
The troubles facing young bow-  
fins, 3-232-33  
Fishes that place their eggs in  
air bubbles, 3-233

#### ***Things to Think About***

Why do darters often fight?  
What kind of nest does the male  
sunfish make?  
How does the stickleback make  
its unusual nest?

What enemies do fishes always  
have?  
Why do not all fish eggs develop  
into adult fishes?

#### ***Picture Hunt***

To what fish is the goldfish re-  
lated? 3-227  
What fish is usually caught by  
children? 3-228  
When is the female stickleback  
allowed to enter the nest? 3-  
229  
Why are bowfins disliked by

fishermen? 3-230  
Why does the male bowfin cut  
the weeds above his nest? 3  
231  
What bird is trained to catch  
fish? 3-232  
What makes it possible for a fish  
to live in water? 3-233

#### ***Leisure-time Activities***

PROJECT NO. 1: To learn  
something about bubble-nest  
builders, buy a pair of paradise  
fish. Separate the fishes by a  
sheet of glass in a small fish tank.

Remove the glass when the nest  
is quite large. Separate the pair  
if the male attempts to kill the fe-  
male, 3-233

#### ***Summary Statement***

To watch the stickleback build  
its nest and defend it is a thrill-  
ing experience. If during May  
and June you will lie down on the

edge of a pond and look into the  
shallow water, you may see on  
the cleared sandy bottom nests  
built and defended by sunfishes.



These dainty fish that gleam so brightly in the light are one of the familiar "minnows" of the Eastern and Central United States. They are also known as golden shiners - for reasons that are clear. More learnedly, they are called the common roach.

New York Zoological Society

## OUR FINNY FRIENDS *of the BROOK*

*These Tiny Fish Are as Dainty as Jewels but as Brave as a Whale or a Shark; and Some of Them Are Wise Enough to Build a Home to Rear the Children In*

**P**ROBABLY the fish that most of us love best are the tiny things that play around our feet when we wade in the brook, or that stand in solemn rows sunning themselves in some quiet pool. How dainty they look in their cool home!

"A fairy went a-marketing,  
She bought a little fish;  
She put it in a crystal bowl  
Upon a golden dish.  
An hour she spent in wonderment  
And watched its silver gleam;  
And then she gently took it up  
And slipped it in the stream."

It must have been a very tiny fish that the kind fairy returned to its home in the rippling stream—after she had gazed "in wonderment" at the gleaming scales, the delicate fins, and the quick, graceful movements of her dainty little prisoner in the crystal bowl. Perhaps it was a silvery minnow, or maybe one of the darters—those bright, lively little fishes who seem to have such a jolly time whisking about in the cool brook.

There are ever so many of these dainty darters. They are friendly little things and are nearly always to be seen moving about in shoals together. They love clear, swiftly-moving waters where there are plenty of stones to shelter them and green, waving forests of weeds where they can play hide-and-seek.

Some darters are gayly clad in the brightest of colors, others are more quietly dressed in speckled light-brown suits, while some of them are almost as transparent as glass, and look like flickering shadows in the water as they dart here and there with quick, short dashes and sudden twists and turns.

Brisk and bold as they are, the darters are wary little fishes. When they are resting they lie quietly at the bottom of the brook, down among the stones and gravel where it is difficult to see even the most brightly colored of them. But if you disturb them they are up and out of sight in a flash.

One of the boldest and hardiest of all the darters is the fantail, a slim, wiry little fellow, almost black, with a pointed snout



## LIFE IN OUR STREAMS AND BROOKS

and a most determined-looking, thrust-out lower jaw. He loves the splash and dash of hurrying water and chooses the coldest, swiftest streams to live in. There he is a terror to small water insects and little water snails.

His cousin the sand darter is not quite so bold. He is so transparent that you can almost see through him, so he is not likely to attract attention unless he is dashing about. Yet in spite of this the funny little fish is extremely cautious. He shuffles himself well into the loose sand at the bottom of the running brook, with only his wee snout and bright eyes above ground. There, cunningly tucked away, the sand darter watches all that goes on around him in the water world, and darts suddenly from his hiding place to snap at a tiny wriggler or a fly that alights for a moment on the surface of the transparent water.

Even more attractive is the rainbow darter—a gay little fish not much more than two inches long, decked out in all the colors of the rainbow. He is not at all shy, at least in the springtime, when he is so busy and excited that he does not care who sees him. In the spring all fishes appear in their brightest colors. For springtime is courting time, when Nature sees to it that they look their best. The rainbow darter is then gorgeous to behold in his red, blue, green, and brilliant orange suit, with the sharp, spiny fin on his back a deep, clear blue.

### Bold Knights of the Brook

When winter has really gone and the pussy willows by the brookside are hanging out their tassels, numbers of these bright little fishes make their way to the shallows above the swirling rapids, where the bed of the

stream is clear and gravelly and the movement of the water not too swift. Here they start the serious business of life. Each little male darter stakes out a claim, which he regards as his own private territory and holds against all comers. If another bold darter trespasses on his ground, up goes his back fin, displaying its sharp spines in a threatening manner, and the little warrior dashes full tilt at the intruder and fiercely orders him off the premises. Sometimes the other darter will not go. Then a fight begins. The two angry little fishes butt at each other with their heads and slap each other with their tails until one of them has had enough of it and goes off in a

hurry, leaving the victor in proud possession of the gravel patch. But they do not really hurt each other, although they appear to fight so fiercely, and when the battle is over neither seems to be a penny the worse!

But when a lady rainbow darter comes along, the fish in possession of the gravel patch does not drive her away. He politely invites her in and begs her to consider his house as her own. If she accepts the invitation the little lady, after carefully inspecting the ground, scuffles about in the gravel and scoops out a hollow trough. In this little cradle she lays her eggs, while the proud owner of the plot swims round and round her and sends all inquisitive fishes off about their own affairs. Such are the housekeeping arrangements of the smart little pair.

Most of the fishes in the stream are rather quarrelsome in the spring of the year. At least the male fishes are. For as a rule, strange to say, they are much more interested in their little families than is usual among males of other animals. They are ready to fight any other fishes who attempt to interfere with their nursery arrangements. A

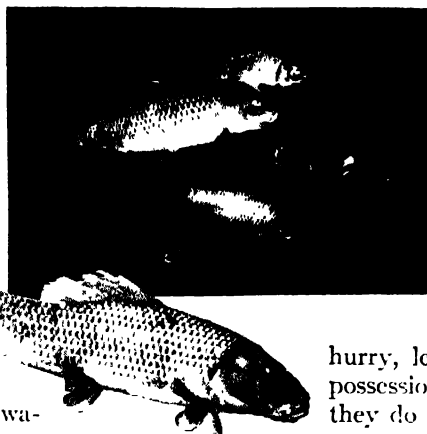


Photo by N. Y. Zoological Society

In the square above is a group of common carp. They are not so pretty as golden carp—or goldfish, as we call them—but they were very highly thought of by the kings of France, who put gold rings through their noses and placed them in the ponds and lakes of their palace grounds at Versailles and Fontainebleau. Below them is a fish known as a chub sucker.

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mother fish usually considers her duties ended as soon as she has laid her eggs, and is content to leave the father to look after them or not, as he chooses.

All the sunfishes are good parents that is to say, every father sunfish is a good parent. Early in the season we may see some of these solemn-looking little fishes busily scooping saucer-shaped holes in the sand or gravel. They carefully pick out all the sharp

fair model of what a sunfish looks like.

But this will not tell you how beautifully colored most of these fishes are. Their glistening coats are marked with spots or stripes of green, blue, red, and orange, and sometimes gleam with tints of copper and gold. The little pumpkin seed himself is a very smart little fellow, as bright and shiny

as a new coin fresh from the mint. He surely does not deserve the abuse that Hiawatha showered



stones with their mouths to leave the inside of the nest and smooth. When he has persuaded the female sunfish to lay her eggs in his nice little nursery, the male sunfish mounts guard and furiously drives away the darters and other small fishes who would eat the eggs if they had the chance.

There are many different kinds of sunfishes living in the lakes and brooks of North America. A few are fine fishes twelve or fourteen inches long, but most of them are quite small, not more than five or six inches from nose to tail, while some are smaller still. Sunfishes are called by all sorts of funny names, such as "coppernose," "dollar-dee," "shell cracker," and "pumpkin seed." The last name is really quite a good one. For if you take a pumpkin seed, add a fan-shaped tail at one end, draw a pointed mouth at the other, then put in a round eye and mark a few scales, you will have a very

Photo by N. Y. Zoological Society  
Even young fishermen can catch these sunfish, which are very good to eat. All that is needed is to sit quietly on the bank until there is a nibble and then pull out the line. Sometimes, it is true, the fish may not be on the end. He may merely have nibbled the worm and not have swallowed it. But the chances are that he will grab the hook eventually.

on him when he found the glittering little fish swinging from his fishing line:

"Slowly upward, wavering, gleaming,  
Rose the Ugudwash, the sun-fish,  
Seized the line of Hiawatha,  
Swung with all his weight upon it.

"But when Hiawatha saw him  
Slowly rising through the water,  
Lifting up his disk refulgent,  
Loud he shouted in derision,  
'Esa! esa! shame upon you!  
You are Ugudwash, the sun-fish,  
You are not the fish I wanted,  
You are not the King of Fishes!"

But after all, Hiawatha was fishing for the great sturgeon, the "King of Fishes," and it must have been annoying to catch an impudent little pumpkin seed instead!

Another little brook fish that is always exceedingly alert and busy in the springtime

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is the stickleback, a proud, independent little fellow who swims by himself and has several sharp spines standing erect upon his back. He is not so very much bigger than a rainbow darter, and is almost as gayly colored in his fresh spring costume, when his silver sides gleam like satin and his scarlet waistcoat is positively dazzling!

The stickleback is not content with a hole in the bed of the stream for his nursery. He makes a real nest for the eggs he hopes to hatch, and takes as much trouble over it as a bird does. You may see him bustling about with an anxious air, examining every clump of weeds and poking his tiny nose among the stones as he hunts around to find the very best spot for his nursery.

When this important point is settled, the stickleback first makes a slight dent in the ground by scuffling around on his chest in the sand. He then collects bits of weeds, straw, and fine rootlets and piles them up on the top of it. He tugs and pushes his material into place with his snout and now and then dives into the middle of the heap and gives it a good shaking; and to prevent the odds and ends from being washed away by the moving water he binds them together with threads of mucus.

### The Courtship of a Stickleback

When he has built up a nice thick bed, hollowed in the center, for the eggs to rest on, the clever little fish proceeds to make a soft, elastic coverlet of sand and mucus

mixed together. This he carefully spreads over the top of the nest, leaving a hole at one side for an entrance.

Now the nest is all ready. But as yet it is empty—and a nest is no good at all like that. So off the stickleback goes to find a mate. Presently back he comes accompanied by a lady stickleback. He shows her his beautiful nest and invites her to “step inside.”

But my lady stickleback is somewhat hard to please. She may turn her back on the nest, as if she does not think much of it, and with a scornful flick of her tiny tail attempt to swim away. This is really too much! After all the pains he has taken to make that nest neat and comfortable no stickleback likes to put up with such contemptuous behavior! He hurries after the disdainful little fish and does his best to persuade her to return. If she *won't* listen to reason, he loses his temper. He butts at her with his head, and begins to push and pull her back to the nest. At last, finding that she will have no peace until she obliges the persistent little fellow, the female stickleback gives way. She wriggles under the coverlet, which is often rather a tight fit for the plump little fish, and as there is no room to turn round, she pushes her way out again at the opposite side, leaving a cluster of eggs lying on the soft weed bed.

Then, without stopping to say good-by, the female stickleback swims off, and this time the male does not attempt to prevent her departure. She may swim all the way to the sea for all he cares, once the tiny eggs are safe inside his nest.

So far, so good. But the male stickleback is seldom contented with just one batch of

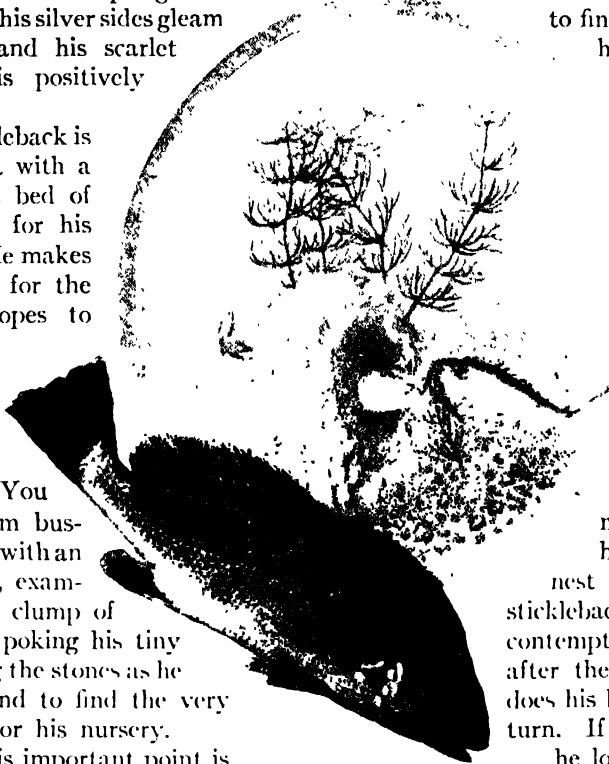


Photo by N. Y. Zoologica! Society

Here are the male and female sticklebacks and their nest. The female is tucked inside the nest laying her eggs, while her husband is bringing more bedding to make the nest even stronger. The large fish below them is a fresh-water drum who is probably hanging around to see if he cannot get some fresh stickleback eggs.

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eggs. He coaxes or bullies two or three more lady sticklebacks into his nest before he is quite satisfied; and one after another they swim away, leaving him in sole charge of the nursery.

### A Patient, Watchful Father

But the little father does not seem to mind that. Apparently he prefers to look after the eggs himself, with no interference from anybody. And how busy he is! When he is not fussing round the nest and picking off odds and ends of rubbish, tucking in the coverlet, or chasing away any water folk who come too near, the anxious little parent hovers over the opening and vigorously fans his tiny fins to keep fresh currents of water constantly flowing over the eggs.

Yet accidents will happen, even in the peaceful water world. In spite of all his care and vigilance some clumsy creature may blunder on the nest, tearing it open and scattering the precious eggs in the water. Then, in an instant, all the sticklebacks from round about come hurrying to the scene and start gobbling up the eggs. The poor little father is nearly frantic. He dashes wildly about trying to drive the greedy things away. But it is of no use. The thieving fishes are too many for him. At last, seeing that he cannot possibly save his eggs from destruction, the weary little fish seems to decide that he might just as well have a few himself, so he gives up the struggle and joins in the feast.

If all goes well, however, and no sad accident occurs to ruin his nest, after nearly a month of anxious care the faithful little parent has his reward. The eggs hatch; and at last Father Stickleback sees a tangle of

baby fishes squirming about in his nest! Hastily he enlarges the opening, or even pulls the coverlet right off to make an open cradle for the wee things. And until the youngsters are fit to go out into the water world and fend for themselves, he remains on guard to drive off any prowling creature who might harm them.

Now and then we may be so lucky as to see a wee fish with ten spines on his back swimming among the water weeds in a shallow pool or quiet stream. This is the ten-spined stickleback, or the "tinker," as he is often called because in the spring-time he is nearly black all over. At other seasons of the year he is dull green.

The tinker is rather a rare little fish. He is smaller than his three-spined cousin, and he fixes his nest to the stems of water weeds instead of building it on the ground.

These sprightly little sticklebacks live and build their neat little nests in gently-rippling brooks and quiet pools in nearly all northern countries the wide world round. But the bowfin—another fish that builds a nest and takes care of its children—is a true American, and is to be seen only in the Great Lakes and a few rivers of the United States.

### The Lazy Bowfin

The bowfin gets its name from the long straight fin that runs nearly all the way down the middle of its back. It is a good-sized fish. The female is about twenty-four inches long, but the male is a good deal smaller. He is seldom more than eighteen inches long and is distinguished by a large black spot on his tail.

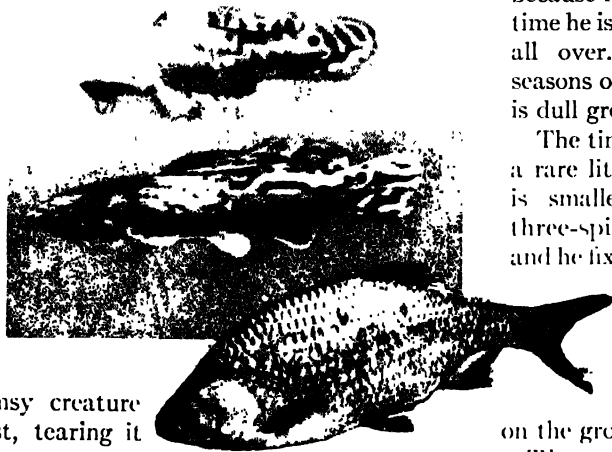


Photo by N. Y. Zoological Society

The bowfins have pretty spotted coats and very domestic habits, but they are not very intelligent or exacting about their diet. They will bite at anything put on the hook, much to the disgust of the fisherman; for they are not good to eat like the pearl roach you see just below them.

## LIFE IN OUR STREAMS AND BROOKS



Above you see the shallow, reedy spot the male bowfin has picked for his nest. Before he builds it he must bite off the tops of the reeds and crush down masses of water growth so that the sun will be sure to reach the nest and make it warm for the baby bowfins. He will see to it that they have a soft, hollow little nursery. The poor fellow has to do the work all by himself, for the female takes no interest. She seems to think all that is man's work.



Photo by American Museum of Natural History

When the little nursery is all ready, the mother is persuaded to leave off her gadding just long enough to lay her eggs. And then, without so much as a backward glance, she dashes right off, leaving her little family in the charge of the male bowfin.

This scaly little gentleman takes his duties very seriously indeed. He hovers anxiously about until the baby fish are quite capable of taking care of themselves.

Bowfins have many different names. They are called mudfishes, dogfishes, grindle, or lawyers. They are rather lazy fishes, but they are extremely greedy; they eat enormous quantities of fish eggs, and all sorts of water creatures, including smaller fish.

Most of the bowfins keep to the deep waters of the lakes; and in the winter time they are usually half asleep on the mud down at the bottom. But toward the end of April

or the beginning of May they wake up and seek the reedy shallows round the margin of the lake, where the rushes are all fresh and green and the blue flags are unfurled.

Here the lady bowfins swim about, doing nothing in particular, while their little mates set to work to make the nests for the eggs. This they do by circling round and round in a thick clump of rushes, crushing and beating down the soft green growth to make

## LIFE IN OUR STREAMS AND BROOKS

an empty space in the middle. Any leaf or stem that overshadows the spot is carefully bitten off and carried away to allow the sun to shine down through the water and flood the little green nursery with its warm, life-giving rays.

### A Family of Three Hundred

When the eggs are safely in the nest the mother goes off to enjoy herself in the usual careless way, leaving her good husband to guard them and look after the children when they arrive.

He has not very long to wait. The eggs hatch soon in the sunny nursery, and in less than a week—or a little longer if the weather is cloudy—two or three hundred baby fishes are wriggling about on the nursery floor. So tiny are these baby bowfins that most of them would certainly be washed away through the network of weeds which surround them if each fishling were not provided with a little sucker by which it anchors itself to the weedy carpet.

**Few fish can escape the watchful eye and swift beak of the great blue heron, one of America's finest fishermen.**



Photo by American Museum of Natural History, New York

For a day or two the baby fishes stay quietly at home, while the male circles round about the nest to keep all enemies at bay. Then one fine day when the babies have grown a little stronger and are ready to leave their nursery, they all rise together in a bunch and float out into the open water to have their first glimpse of the outside world.

Away they go, still keeping together, the father swimming round them, sometimes under and sometimes over the moving mass of tiny fishes, and rounding up any straggler who falls out of the ranks.

### The Family Breaks Up

So for a week or two the devoted parent guards his large family of tiny fishes. The children seem to understand that it is dangerous to stray far from his protection and all keep as close to him as they can. But there comes a day when, like most young things, the little bowfins grow tired of leading strings. They are stronger now, and they feel quite sure that they are able to take care of themselves. So off they all go to fate or fortune. Most of them probably disappear down the throats of larger fishes.

The open water is a perilous place for baby fishes. Danger lurks in every clump of weed and around every bend and corner of the stream. While they are very young they are snapped at by nearly every water creature they meet. Many even fall victim to big water beetles and the fearsome, ogrelike insects.

When they are older and wiser they still have many enemies to fear. The long-legged heron waits and watches among the reed beds, standing so still that the fishes never notice him until he strikes with so swift and sure an aim that he seldom misses his prey. Fish hawks swoop down to the water and seize the poor things as they swim quietly just below the surface. Otters chase them up and down the stream. And they are attacked and devoured by fierce hunting fishes bigger and more powerful than themselves.

In the placid streams, the bubbling brooks, and the swift rivers, ruthless hunters are forever chasing and killing the feeble water folk, and many a conflict takes place among the more warlike inhabitants. Yet life goes

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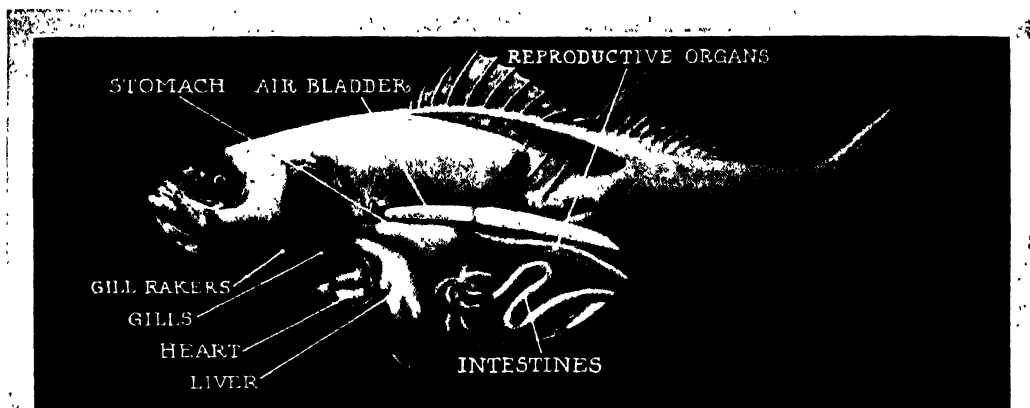


Photo by American Museum of Natural History

**These are the neat internal arrangements that enable a fish to live and be happy in his watery home. The**

**air bladder helps him to rise and sink in the water, and the gills serve him in place of lungs.**

merrily on. Although they are watchful and cautious the little water creatures probably are not really afraid much of the time. They certainly do not worry. And if they are caught and eaten, the end comes so swiftly, as a rule, that they have no time to feel much fear or pain.

So on the whole the fishes in the stream lead a fairly peaceful and comfortable sort of life. They do not interfere very much with one another, except in the springtime, when nearly all fishes are inclined to be excited and quarrelsome. They feed mostly on the worms that wriggle at the bottom of the water and the flies that dance over the surface, but they eat insects and small creatures of all sorts. And if they snap up one another's eggs and swallow a great many baby fishes, it is really a good thing that they do; for fishes produce such immense quantities of eggs that if they all hatched and every wee thing grew up, the lakes, brooks, and rivers would be choked with them.

One of the most wonderful little nests is made by a tiny fish living in the far-off rivers of Northern India. It is called the rainbow fish because its small body is surrounded with brilliantly colored bands of red and blue. Its nest is made from the slender threads of those water weeds which look like tufts of fine green hair. These the little fish weaves together in the most clever fashion to make a tiny raft, measuring about four

inches in diameter; and all round the edges he weaves a thick border—like the broad, flat brim of a hat. As he works, the cunning little weaver keeps blowing bubbles from his mouth, which, becoming entangled with the mass of weed, make the raft so buoyant that it floats lightly on the top of the water.

When the nest is done, the rainbow fish persuades several ladies of his tribe to lay their eggs underneath it. He then mounts guard over his treasures; and as soon as the eggs are hatched, he unravels the "hat brim" of the nest until it hangs down all around like a fringed curtain—in order to keep the babies safely at home till they are old enough to start out in life.

Another little foreigner, the Chinese paradise fish, makes his nest entirely of bubbles. He gulps in a great mouthful of air and then blows it out again surrounded by a film of mucus—as a soap bubble is surrounded by a film of soap. The bubbles all cling together and float like a little mass of foam on the top of the water, and the eggs are placed underneath them. The little fellow grows very much excited when his nursery is ready. He chases the little lady fish about, and drives her under his bubble nest in the most rough-and-ready fashion. Then he watches anxiously, and if one of the precious eggs floats outside the nest he dashes after it, like a dog after a ball, and brings it back in his mouth.

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# ***The* STORY of FRESH-WATER LIFE**

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## **Reading Unit No. 3**

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### **SOME FISH WE LIKE TO CATCH**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

Where trout live, 3-235  
What the fisherman knows about the perch, 3-236  
What a minnow really is, 3-237  
How the bass uses its mouth, 3-238

Why the pike and muskellunge are called "wolves of the streams," 3-238  
The armored garfishes, 3-240  
Ferocious catfishes, 3-242

#### ***Things to Think About***

Where is the best place to fish for trout?  
Why can any boy or girl catch young perch, but not old ones?  
What may cause a black bass to choke to death?  
What fresh-water fish will devour

a rat?  
How can a pike surprise its prey?  
Why is it dangerous to handle certain catfish carelessly?  
What kind of parent is the father catfish?

#### ***Picture Hunt***

Why is trout fishing considered a fine art? 3-237  
What would you consider a good bait for large perch? 3-237  
How does the appetite of a bass sometimes cause its death? 3-239

What dangerous habits have the muskellunge? 3-240  
Why do not more people eat garfish? 3-241  
Which carp has been domesticated? 3-241

#### ***Leisure-time Activities***

PROJECT NO. 1: Find out from the State Conservation Department what fish may be kept and when you may fish for them. Consult a dealer in fishing tackle. Using the proper bait, see if you can catch some trout, perch, pike,

or bass, 3-235-39

PROJECT NO. 2: Visit a museum or aquarium and become familiar with the kinds of fish you might catch in streams or lakes.

#### ***Summary Statement***

Trout live in swiftly flowing streams. Perch are found in ponds and lakes. The bass and

pike devour smaller fish and even birds and rats.



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Photo by Edwin Way Teale

Every small stream has at least one wary old fish that has grown to great size and refuses to be caught. He

rarely shows himself. Like this yellow perch he spends his time in some deep hole or hiding under a log.

### SOME FISH WE LIKE *to* CATCH

*Have You Ever Hooked a Minnow Four Feet Long, or a Six-Foot Muskellunge? Perhaps You Prefer to Angle for a Wily Trout, or a Gallant Salmon as It Journeys In from Sea*

**O**F ALL the fresh-water fishes none is more charming than the brook trout—so gay in its glistening coat of mail, all dotted with black and crimson and spangled with silver and gold, so graceful as it darts like an arrow through the waters, so alert and dashing as it hunts for food, sometimes leaping right out of the water to seize a quick-winged fly.

The trout is a fish of many waters. It makes its home in clear brooks and gliding rivers, and in deep, mysterious pools; but best of all it loves a tumbling mountain stream with a clean, gravelly bed and overhanging, weed-covered banks, where it may rest in the shadow during the sunny hours of the day.

When they are young, trout are heedless and fond of adventure. They love to explore the streams and see life. As they grow older they are less restless and more cautious; and although they are still fond of traveling at certain times of the year, the old trout will stay for a long time in the same pool or stretch of water, cunningly hiding under big stones or in thick growths of weed until the evening, when they come out to look for food.

There are many different kinds of trout—the speckled trout, the golden trout, the silver trout, the steelhead, and the Great Lake trout, to mention only a few of them. They are all bright, fascinating fishes, full of life and vigor; but most delightful of all,

## LIFE IN OUR STREAMS AND BROOKS



Photo by N. Y. Zoological Society

There are many different kinds of trout with many different shiny coats. Some have the wanderlust and

perhaps, is the rainbow trout that haunts the bubbling mountain streams. It is a joy to see this splendid fish as it flashes through the water, or to watch the wonderful play of the rainbow tints on its shimmering scales as it swims quietly about, snapping at flies.

The grayling is another beautiful fish of the cool northern streams. So

must be forever traveling through rapid streams; some stay in closed ponds. Above is a group of hybrid trout.

small cousins, the little darters, do—for the darters are really a dwarf race of perches.

Perches are sociable fishes. Schools of young ones roam about together, merrily chasing the water insects and fresh-water shrimps. They

are heedless young things, and snap eagerly at everything moving in the water; so before they learn wisdom they are easily caught with almost any



Photo by N. Y. Zoological Society

lovely are the delicate tints of soft green, pale blue, rose, and purple on its glistening scales and graceful fins that the grayling has been called "the flower of fishes"—and not undeservedly!

Then there are the perches. You may know them by broad, dark bars on their greenish-brown or golden-yellow sides, and by the sharp spines on their back fins. When they are angry or frightened they erect their spiny fins in a threatening way, just as their

Brook trout, shown in the oval, and brown trout, shown below, do not leave the streams or lakes in which they live; and their size and coloring vary according to their surroundings. That is one reason why there are so many different kinds of them.

kind of bait temptingly dangled before them.

But they grow wiser as they grow older. Grown-up perches swim sedately in and out of the weed patches, keeping company with fishes of their own size and leaving the young folk to go their own reckless way. Unless they are very hungry, they are not so easily tricked by tempting morsels which conceal sharp hooks. They eat all the little fishes they can catch, and are a terror to small fry of all kinds.

## LIFE IN OUR STREAMS AND BROOKS



Photo by N. Y. Zoological Society

Rainbow trout are found west of the Rocky Mountains, where man has imported them to stock the lakes and

streams. They are great fun to catch because they are very wary and will not bite at everything.

With fin erect a big perch will dart into the middle of a school of silvery minnows, snapping up one after another while the little victims dash frantically hither and thither, and often jump clear out of the water to escape the gaping jaws of the big greedy fish.

### What Is a Minnow?

The timid little minnows are terribly persecuted by all the larger fishes. They are good to eat and easy to capture, and they have no sharp spines to protect them from their enemies, as the darters have.

Although most minnows are very small, they are not all tiny. In America all very little fish are called minnows, but that is a mistake, for the minnows really are a tribe by themselves. Some of them are

of quite a good size, and a few are fine fishes a foot or more in length. One of the largest is the squawfish, rather a grim-looking fellow in a muddy, greenish-colored suit; he may be two, three, or even four feet long.

On spring and summer evenings large schools of squawfish may be seen swimming about in many of the streams and rivers of California, snapping greedily at the swarms of insects that fall upon the surface of the water. But when winter is approaching, large numbers of these fishes retire to deep waters, where fishing for squawfish through holes in the ice is a great sport.

The perch is a handsome fish which keeps to the quieter waters of lakes or rivers. He is very greedy and feeds on small fishes and worms. Below is the yellow perch of North America.

When the little minnows are fleeing from a hungry perch they may have the bad luck to meet another and even more alarming fish, who is on the lookout for something nice for supper. This is the large-mouthed

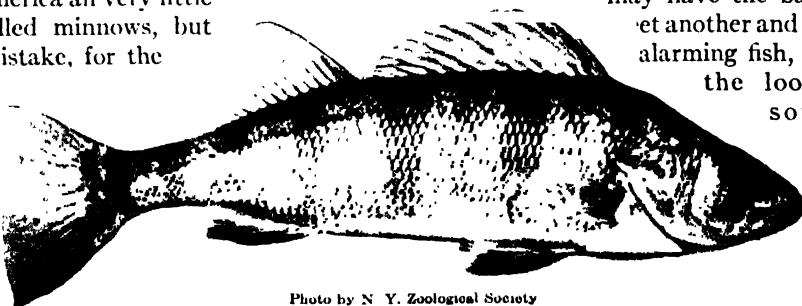


Photo by N. Y. Zoological Society

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black bass—a bold, big, handsome fellow with such an enormous gaping mouth that he can gulp the little fishes down wholesale—and he does it, too, without the slightest conscience!

This masterful fish is a tyrant of the stream, the terror, not only of little fishes, but of quite big ones as well; for his mouth is so surprisingly wide that he can swallow a fish almost as big as himself, though when he does this he usually chokes himself and so is punished for his greediness!

The black bass is not really black. He is dark green, with silvery sides; but in his young days he has a blackish stripe running in a wavy line from his throat to his tail fin. This has given him his name, although as he grows older the stripe disappears.

The large-mouthed black bass has a cousin called the small-mouthed black bass. He is equally bold and greedy, though since his mouth is of a more ordinary size, he is not able to swallow such huge morsels. Both these fishes may sometimes be found hunting in the same waters, but the large-mouthed fellow really likes gently moving streams and quiet, shallow pools best, while his small-mouthed relative prefers cooler, more swiftly running waters. But wherever they are, the two bold black basses always behave as if they owned the water and all the creatures in it, and tyrannize over the weaker, more peaceful inhabitants.

### The Wolves of the Streams

Another terror of the water world is the fierce and greedy pike. Not only does he hunt weaker fishes of all sorts, including the small pike known as the pickerel, but he will seize and devour frogs, rats, and young water birds. In fact he will kill and eat anything that is not too big to tackle.

The pike shows his fierce character almost as soon as he is hatched. When only a few inches long he begins to prey on other baby fishes, and the older and stronger he grows the more savage is his behavior. A full-grown river pike may measure four feet in length, so you can imagine how the vicious hunter is feared by other water folk. He is a

gloomy, solitary fish, preferring to live and hunt alone, and he will furiously chase away any other pike that ventures on his own particular feeding ground.

The pike is cunning, too. Lying as motionless as a log in the water or lurking among the reeds, where his mottled coloring of brown, green, and yellow helps to conceal him, he awaits his prey. Then, when a peaceful fish swims quietly by, with a sudden dash he darts upon the poor thing and seizes it in his strong jaws.

In addition to the strong, sharp teeth with which his jaws are armed, the pike has several rows of movable teeth, pointing backward, set in the roof of his mouth. These prevent the escape of the victim, however hard it may struggle.

Fishermen do not like these fierce, greedy fishes because

they destroy such large quantities of salmon, trout, and other valuable food fishes. Whether they haunt the streams of the New World or the Old, all the pikes bear the same bad character and make themselves a nuisance. But the most savage of all is the muskellunge (müs'kě-lŭnj), the giant pike of North America. It is a bold fish about six feet long, and it spends its days hunting and killing all the other fishes living in the neighborhood. Of course this gigantic pike does not invade shallow brooks and pools. It makes its home in the Great Lakes and deep northern rivers, where there is room to move about and plenty of good hunting.



Photo by Putnam County C. of C., Fla. This lucky man is showing, with pardonable pride, the large-mouthed bass he has caught. These fish like sluggish waters and eat smaller fish, frogs, snakes, and even rats.

## LIFE IN OUR STREAMS AND BROOKS

A. The striped bass at the right has tried to swallow whole a two-pound carp and has died in the attempt. The bass weighs forty-four pounds.

D. This black bass, which once swam in the waters of Hardee County, Florida, was record-breaking in length, and very stocky in build.

B. Calico bass are silvery-olive with dark green spots. Both they and the rock bass (C) belong chiefly to the Mississippi Valley and Great Lakes regions.

E. A large-mouthed bass. F. The small-mouthed bass, like the trout, prefers clear, cool, running water.



Photos by Field & Stream, N. Y. Zoological Society, and Hardee County, Fla., C. of C.

## LIFE IN OUR STREAMS AND BROOKS

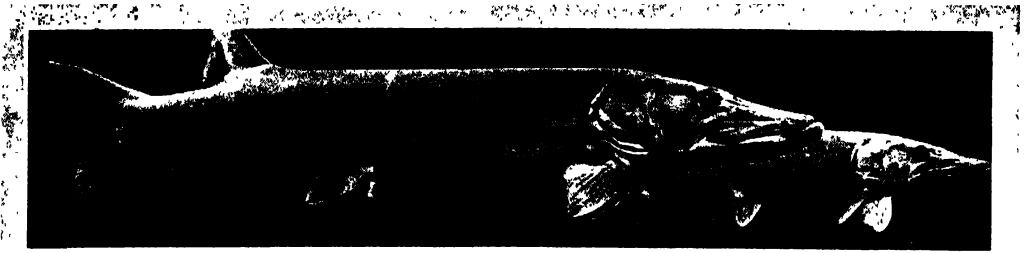


Photo by N. Y. Zoological Society

The six-foot muskellunge is the largest of the American pike, and even fiercer than he looks. He feeds on

other fish, on frogs, voles, and water birds, and is even said to have attacked small boys in swimming!

Another giant of the lakes and rivers is the garfish, or garpike, as it is often called, although it is not really a pike; it is more nearly related to the curious bowfins. In its ways, however, the garfish is very much like a pike, for it loves to lie in wait among the reeds and dash out with a sudden swift rush upon its luckless prey.

### Fish with Long Noses

The garfish is most curious to look at. It is very long and very thin, with an extraordinary snout—like a long, flat, narrow beak. Its long thin body is clothed in a complete suit of armor of hard, bony scales, which shine as if they had been well polished; and its fearsome-looking beak is armed down its entire length with strong, sharp teeth.

There are two kinds of these queer fishes in the lakes and rivers of the United States—the long-nosed gar, which grows to about five feet in length, and the short-nosed gar, which is much the same size but has a shorter, broader beak. Bigger still is the alligator gar of Mexico. He really is a giant—ten or twelve feet from the tip of his beak to his tail is no unusual length for the creature! Tales are told of alligator garfish twenty feet long, but it is doubtful if a monster of this size has ever actually been caught; and since it is by no means easy to guess

the exact size of a fish when it is swimming in the water, these stories may be somewhat exaggerated. In fact, almost any fish seems to have something about it that sets the human imagination running.

Anyway, the alligator gar is quite big enough to scare off all the peaceful water folk when they see him coming. He destroys an enormous quantity of them and annoys the fishermen by tearing their nets with his long-toothed beak.

### How Young Gars Begin Life

Baby garfishes are very funny little things. Instead of a beak, each tiny fish has a row of little suckers all around its mouth, with which it clings fast to a stone or the stem of some water plant, to prevent the current in the water from sweeping it away. For the first two or three weeks after they are hatched, the baby garfish hardly move at all. Then their suckers gradually disappear, their beaks begin to grow, and they set off to explore the water world. They paddle about, and at first are content with a diet of small water insects. But before long these hustling young garfish are excitedly chasing all the other little fishes in the stream and eating every one they can catch.

Yet another giant of the Great Lakes and rivers is

The pike is as stealthy as he is greedy. He will lie motionless on the surface of the water or hidden among reeds till other fish, thinking he is just a log, come near enough to be gobbled up.

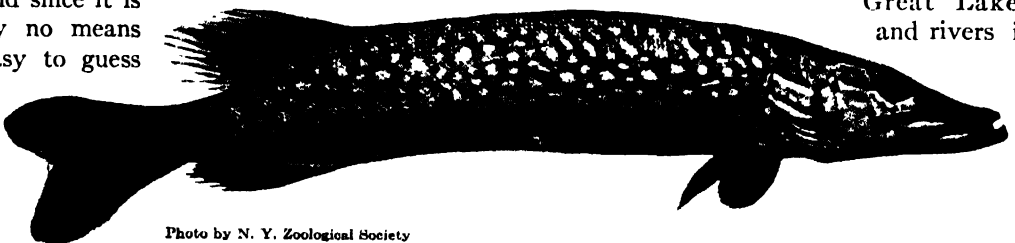


Photo by N. Y. Zoological Society

## LIFE IN OUR STREAMS AND BROOKS

A. The honors in this case must go to the pike that opened its mouth first—or wider!

B. The golden carp, or goldfish, is a domestic variety bred to produce brilliant colors.

D. It is easy to see that the long, thin body of this garfish was built for speed, just as his beaklike jaw filled with sharp teeth is meant for preying on smaller animals. Incidentally, garfish are good to eat, although some people object to the bones, which are a green, unhealthy color even when cooked.

E. This young fisherman has just caught a rainbow trout. F. The man below is mounting a short-nosed gar. After removing its insides, he preserved the scaly skin with chemicals. Then when it was dry he re-stuffed it with sawdust or plaster of Paris. Now he is paint-

C. The alligator gar of Mexico is the largest of the garfish, sometimes growing to be ten or twelve feet long. No wonder he is a tyrant of the waters!

ing it exactly as an artist might paint a picture.

Photos by Field & Stream, American Museum of Natural History, and Greater Minn. Assn.

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the blue catfish, a ferocious-looking monster four or five feet long. He certainly is no beauty.

"His face is broad and flat and glum;  
He's like some monstrous miller's thumb;  
He's bearded like the pard.  
Beholding him the grayling flee,  
The trout take refuge in the sea,  
The gudgeon go on guard."

And no wonder! For the catfish is as ferocious as he looks. He will go after anything, even the legs of people bathing in his waters.

This strange fish does not really have a beard, but on his snout are some long feelers called barbels. They look like whiskers, and that is why he is called a catfish. The fish can taste with those barbels. In fact certain kinds of fish can taste things with their fins, and with other organs of taste scattered all over their bodies. It is as if we could taste a piece of cake with our fingers.

There are several different kinds of catfish. Most of them are a good deal smaller than the blue cat, but the big yellow cat, sometimes called the "granny cat," is quite as large and every bit as fierce.

In the spring, when the waters of the Mississippi rise and flood the fields and woods for miles around, the catfish, both blue and yellow, leave the deep river and

"take to the woods"—as people say. Here large numbers of them are caught. Then the big fishes are packed in boxes and shipped to many parts of the country.

It is not everyone who would care to have the catfish for dinner, though they are really not bad when they are well cooked, and some people, especially colored folk, like them very much.

A number of small catfish called "stone cats" and "mad toms" live in the lakes and shallower streams of the United States. They do not look so forbidding as their big blue and yellow cousins, but it is just as well to be cautious in handling these little "cats," for they are armed with two poisonous spines, and if they prick you, your skin will smart pretty badly. The stone cats are about a foot in length, but the mad toms are quite tiny fishes, not more than three or four inches long.

Bad-tempered and greedy as all catfish are, they do, as a rule, look after the welfare of their children. The eggs are carefully placed in some secluded spot near the bank of a weedy pool or sheltered stream, and the father stays near at hand to protect them. One small catfish, called the bullhead or the horned pout, may often be seen swimming near the shore in the springtime, leading a whole crowd of wee fishes about like a fussy hen with a brood of young chickens.

This ferocious-looking fellow, so unlike the graceful trout or the sparkling sunfish, is the Mississippi catfish. His thick skin is quite free of scales.



In Africa is an electric catfish that carries a "battery" around its body just under the skin. It can give a very severe electric shock.

Photo by N. Y. Zoological Society



# **The STORY of FRESH-WATER LIFE**

## **Reading Unit No. 4**

### **KING OF THE LAKE AND MONARCH OF THE STREAM**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

Where the sturgeon is found, 3-244-45

How fishes use their air bladders, 3-245

How salmon fight their way up inland streams, 3-245-46

The adventures of a young salmon, 3-247-49

Why eels leave home forever, 3-250

How baby eels reach the homes of their forefathers, 3-251-52

#### ***Things to Think About***

Why must a sturgeon lay millions of eggs?

How can a fish move up or down in water?

Why do salmon leave the ocean and enter fresh-water streams?

Why do eels travel thousands of miles away from home?

#### ***Picture Hunt***

How large may sturgeons grow? 3-245

What happens to salmon after they lay their eggs? 3-246

Why do baby fish have yolk sacs? 3-247

What kind of work is done at a fish hatchery? 3-248

How do eels know where they must lay their eggs? 3-251

Why are lampreys dangerous to other fish? 3-252

#### ***Related Material***

What does a fish's air bladder look like? 3-196, 233

How does instinct differ from intelligence? 2-393

Are eels and salmon the only animals that migrate? 4-2-3

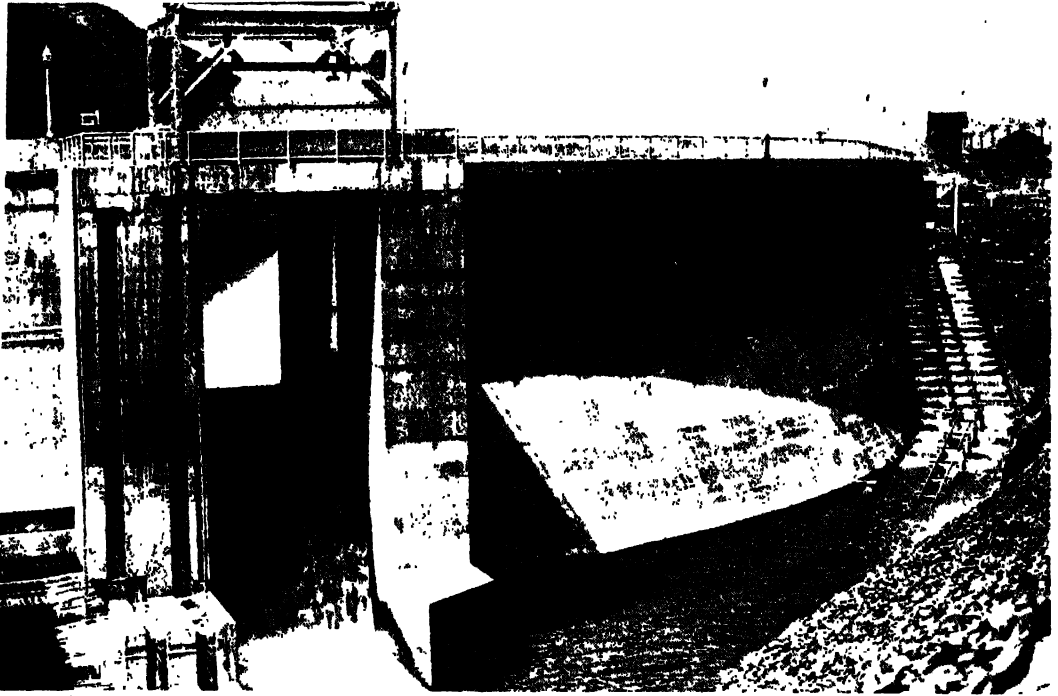
What is meant by migration? 4-2-3

#### ***Summary Statement***

Eels and salmon are migratory fishes. When the time comes for eels to reproduce, they overcome all obstacles and fight their way

back to the ocean where they were born! For the same purpose salmon go from the ocean to inland streams.

## LIFE IN OUR STREAMS AND BROOKS



Courtesy Washington State Department of Conservation and Development Photo by K. S. Brown

At the right, above, is a ladder but not for building. Every season the salmon leap up its series of tiny waterfalls and so, step by step, climb over Grand Coulee

Dam on their way up the river to spawn. Fish ladders like this one were the means of saving the west-coast salmon industry when the great dam was built.

### *KING of the LAKE and MONARCH of the STREAM*

*The Noble Sturgeon and the Gallant Salmon Journey Hundreds of Miles to See the Great Life of the Open Ocean, and like the Eels They Never Lose Their Way*

**T**HE Indians used to call the sturgeon the "King of Fishes." But they did not have much knowledge of history! For if he is a king, he is a very mild one. He does not attempt to rule the waters as the fierce pike and catfish do. He is a quiet and dignified person who goes his own way and seldom interferes with other fishes.

The sturgeon is somewhat like the garfish, but he is a much stouter, heavier fish, and each bony plate of his armor is raised in the center to form a short, blunt spine. He has a rather long, pointed snout, but his mouth is quite small; and since he has no teeth, only tiny things like minnows have any cause to fear him—even though he is such a big, strong fellow. The sturgeon feeds mostly

on water plants and the small, soft creatures that lie half buried at the bottom of the river. Moving slowly along, more as if he were crawling than swimming, the great fish stirs up the sand with his snout and feels about for his prey with the four long feelers on the end of his nose. Then he pushes out his lips to form a kind of funnel and sucks up his food with much relish.

The lake sturgeon, a fine, big fish often five or even six feet long, lives in the Great Lakes of North America all the year round; but the common sturgeon and the white sturgeon—which are still larger when fully grown—and several other smaller members of the family are only visitors to the fresh inland waters. Their real home is in the sea.

## LIFE IN OUR STREAMS AND BROOKS

They live most of their lives in or near the bays round about the coast. But every year when spring comes round, the sturgeons leave the restless, tumbling waters and journey up the rivers to spend a few months in fresh, calmly-flowing streams.

### How Many Eggs Does a Sturgeon Lay?

While they are there the great fishes deposit their eggs on the river beds. Each mother sturgeon lays about three million eggs in a season; but since many of these are eaten up by the regular inhabitants of the rivers, the visitors have far fewer children than eggs; and of course most of the children are also eaten up. Now and then a sturgeon may like fresh-water life so much that he will stay in the rivers altogether, but most of the big fishes go back to their homes in the sea before cold weather sets in.

Sturgeons are very valuable fishes. Their eggs, or caviare, when dressed and salted, are sold as "caviare"; and gelatin is prepared from their air bladders. Air bladders are long, silvery sacks somewhat like the gas bags of an airship. They run along beneath the spines of most fishes. It is these air bladders that make it possible for fish to rise or fall in the water so easily. When a fish rises, its air bladder is filled with a gas secreted from the blood and up goes the fish to the top as lightly as a bubble. When the fish dives to the bottom of the water, the gas is absorbed into the blood again, and the fish sinks quickly downward. In fact, the fish rises and falls in the water in almost exactly the same way that a balloon rises and falls in the air.

Sturgeons live round

about the seacoasts and ascend the rivers of northern regions both in the New and in the Old Worlds. The Russian sturgeon is the biggest of all and may weigh as much as three thousand pounds. And in the Harlem River, right in New York City, a sturgeon weighing 406½ pounds was caught not long ago. Occasionally the "King of Fishes" wanders into British waters. Then it really is a "royal fish," for by a very ancient law "all whales and great sturgeons" caught in British waters belong to the king. Even in these days a fine sturgeon is usually presented to the reigning monarch, but one has never heard of a whale's being sent to Buckingham Palace.

### The Prince of Fishes

If the sturgeon is the "King of Fishes," the salmon must surely be the prince—he moves so proudly through the waters in his glistening armor of silver and blue, he is so dashing and courageous, so noble a fish in every way. He does not live all the year round in fresh water. He spends the winter in the sea, and is a summer visitor to the inland streams and rivers—for like most people of rank and importance the salmon has both a winter and a summer residence.

In the springtime large quantities of salmon leave their ocean home and enter the mouths of the rivers, which are then pouring their flood waters into the sea. The cool, fresh currents excite and delight the long silvery fishes. They twist and turn and leap in the water, playing like a party of children starting off on a holiday. Then, turning tail to the sea, they set out on their long journey up the river.

Nothing daunts these bold travelers. No current is strong

Long-nosed and short-nosed sturgeons, the two varieties shown here, sometimes grow to a length of eighteen feet. Their barbels, which look like whiskers, are used as feelers to help them look for food.

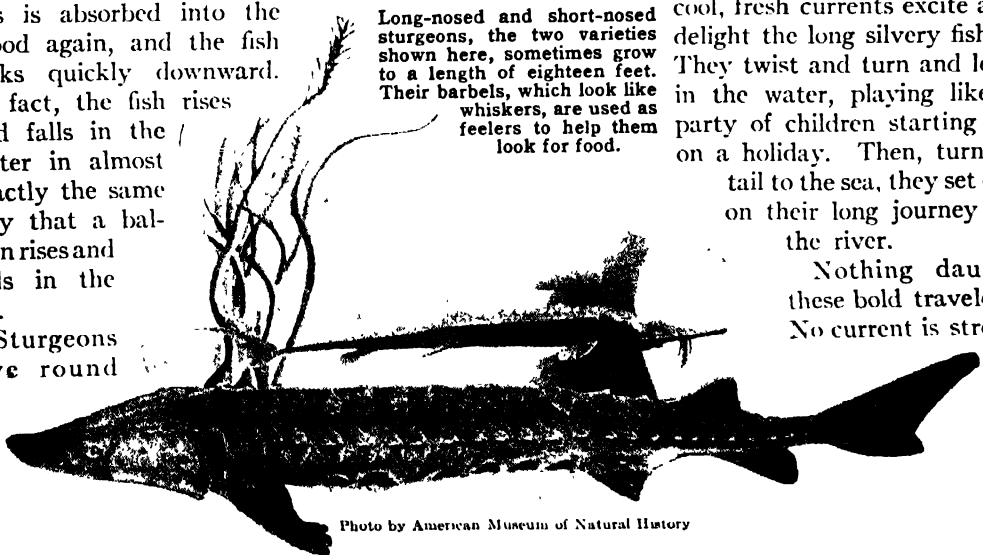


Photo by American Museum of Natural History

## LIFE IN OUR STREAMS AND BROOKS

enough to stop them. Even when they find themselves tossed about in the swirling whirlpools below a dam or a natural waterfall, the sturdy fishes will not turn back. Again and again they dash into the foaming torrent, leaping and bounding six or seven feet into the air. Again and again they are swept back. But the salmon refuse to be beaten. With a last determined rush and a higher jump, nearly all the brave fishes succeed in leaping the fall and landing in the upper waters.



Then on they go, day after day, sometimes resting for a while in a quiet pool, then again swimming steadily forward up the rivers and little rippling streams until they have journeyed hundreds of miles away from the sea.

Yet not all the strong, handsome fishes that set out on their long, tiring journey reach the peaceful pools far inland toward which they travel so bravely. They have many perils to face besides the rushing waters of the dams and falls. All along the rivers fishermen are on the watch for the coming of the salmon. And the fish are so hemmed in by the snares set to catch them that it is a wonder how any manage to escape. Thousands are taken in nets, hauled into boats, and carried away to the canneries. Yet in spite of all the dangers they meet on their way, a great many salmon do get through and arrive safe in the quiet upper reaches of the rivers.

From early spring until autumn fresh relays of these travelers are constantly arriving in the rivers and making their way upstream. Those who set out early in the year make the longest journey; late comers have not time to go so far.

In the spring the salmon are at their best, full of health and strength and clad in silvery scales which glisten in the sunshine. But in the autumn one hardly recognizes the splendid fishes, so sadly are they changed in appearance. They lose their silver sheen and turn a dull,

dingy color. They also lose their slim, graceful shape and grow awkward and ungainly. The male salmon, especially, look pitiful; their sides fall in, their backs are humped, their snouts grow out, and the lower jaw turns up like a great hooked beak. It is no use catching salmon at this time, for they are quite unfit for food.

### How a Salmon Makes Her Nest

As the autumn days grow colder the females set to work to make shallow trenches in the bed of the stream—by wriggling and shuffling about in the loose gravel. In these excavations they lay their eggs, and carefully cover them over in order that they may not be washed away or eaten up by other fishes. While they are engaged in this important work, their mates, who are very fierce and irritable at this time, swim around and

## LIFE IN OUR STREAMS AND BROOKS

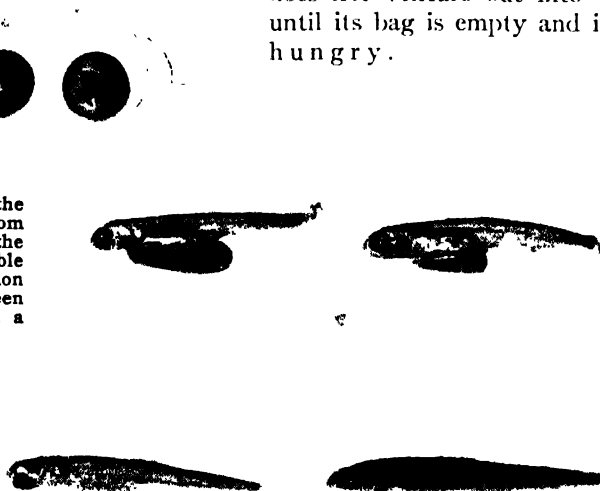
savagely attack one another with their hooked fighting jaws. And the gallant male salmon along the Pacific coast helps his mate to make the nest, or does the bulk of the work himself.

By the time all this excitement is over and the eggs are safely hidden in the sand, the

bulging food bag attached to its body, and so looks more like a tadpole than a baby fish. This queer bag is the "yolk sac." It is filled with yolk of egg. And on this the little creature feeds for the first few weeks of its life. While the food lasts, the baby salmon hides under a rock or a stone. It does not venture out into the open water until its bag is empty and it begins to feel hungry.

The yolk sac gets smaller and smaller as the fish grows. When it finally disappears, he may leave the spawning ground, but still must feed in fresh waters for a while.

Here are eight stages in the growth of a baby salmon, from the day the egg is laid to the time when the little fish is able to take care of himself. Salmon eggs are laid, usually between September and January, in a gravel bed in a fairly rapid stream, and hatch out at the end of the winter. The "fry," as they are then called, get their food for the first two months from the large yolk sac which you see attached to their bodies.



parent fishes are quite worn out. After resting a while in a quiet pool, a few may be able to make their way back to the sea, where they soon recover their strength; but most of them are so weak and feeble that they float down the stream, tail first, and soon die from exhaustion. In America none of them live to reach the sea.

### Eggs Like Carnelian Beads

Salmon eggs are pretty things. They are rather like deep-red carnelian beads, and about as big as a large pea. All through the cold winter months the eggs lie snugly covered in their shallow beds. Then, when spring comes to wake the sleepy world again, the wee fishes hatch out and soon wriggle their way up through the loose gravel. Along the Pacific coast they are out of their eggs in sixty days, and by spring are back in the sea again.

When they first make their appearance in the world the young salmon are very odd little creatures. Each wee thing has a large,

salmon fry have lost their peculiar shape and look much more like fishes, though they are still hardly an inch long. But they grow very quickly, and before the bright summer days have fairly come, all the salmon nurseries are full of lively young salmon four or five inches long.

A salmon nursery is a delightful place for these water babies to grow up and play in. There is everything a tiny fish can wish for—a clear, shallow stream with a clean, gravelly bed on which the sun shines through sparkling, bubbling water, and plenty of stones and reeds in which to hide when they are tired or frightened.

### What Is a Samlet?

The little fishes are not yet dressed in blue and silver like grown-up salmon. They are a pale brown color, with red speckles; and along their sides are some dark smudges

Canadian Department of Marine and Fisheries

By this time the

## LIFE IN OUR STREAMS AND BROOKS

which look as if someone had touched them with dirty finger tips. These spots are called parr marks, and the young salmon at this period of their life are called "salmon parr" or "samlets."

### Adventures of a Samlet

The samlets have a very good time in their nursery days. They dart here and there, play hide and seek among the stones and weeds, and keep popping up to the top of the water to snap at floating insects. The little fishes are always hungry, and very inquisitive, too, and now and again one will snap at an artificial fly which conceals an angler's hook—only to find itself caught and

The man shown here is stripping the eggs from salmon at a government hatchery, where the eggs are hatched out with the aid of an artificial process.



whisked up into the air. But, although it must have a terrible fright, nothing very serious happens to the heedless little fish. No one would think of taking a samlet—which may one day grow into a fine big salmon—from its nursery while it is too young to be of any value. So it is lifted gently from the hook, put back into the water, and allowed to swim away to recover from its alarming adventure.

### When Samlets Become Smolts

The samlets stay in their nursery waters until they are seven or eight inches long. Then they seem to grow tired of playing about and to begin to feel restless. The stream is always hurrying, hurrying along, and the young fishes soon begin to follow it down toward the sea.

So off they go, to see what lies beyond the sheltered waters where they have spent their early days. Family parties of fifty to seventy bright young things set out gayly together. They have lost their parr marks and are all dressed in traveling suits of shining silvery scales. They change their name too, as well as their coats, for they are no longer called "samlets" or "parrs," but "smolts."

It is always easy to swim with the stream, so at first all goes well. But presently the water

No greedy fish will get a chance at these salmon eggs! Here they are by the millions being sorted for size so that they may be put into the different trays in which they will be hatched.

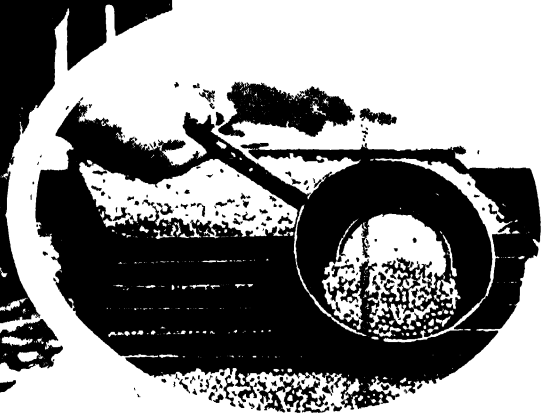


Photo by Canadian Dept. of Fisheries

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## LIFE IN OUR STREAMS AND BROOKS

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Photo by N. Y. Zoological Society

Most salmon live in the sea and migrate to fresh waters only at spawning time. Some, like this land-locked

flows faster and faster, and the smolts are whirled along right up to the edge of a waterfall. Quickly the startled fishes turn themselves about to face the rapid current, and work their little fins and tails as hard as they can to save themselves from being swept away by the rushing waters.

But they are no cowards. The young fishes are true children of those gallant salmon who leaped the falls and fought their way through foaming torrents to the upper reaches of the rivers. So when their first alarm has subsided, one or two of the bolder smolts take courage and allow themselves to be carried backward over the fall. Then one after another, the rest follow their leaders over the top and down into the swirling waters below.

When this exciting adventure is over, the little travelers soon recover from their fright, and on reaching calmer waters again, they once more turn their heads seaward and swim bravely on their way.

But their troubles are by no means over. The smolts have many perils to face before they come to their journey's end. Big, hungry fishes pursue and devour them, otters chase them down the stream, fish hawks swoop down upon them, and flocks of gulls follow them and snatch many a tempting little fish from the

salmon, live in fresh-water lakes. But probably all types of salmon came originally from the sea.

water. So only a few of the plucky young travelers ever reach the sea.

### The Salmon's Happy Hunting Ground

Those who do come safely through all the dangers of the long, long trail now find themselves "in clover." There is such an abundance of good food in the sea and the salt water is so invigorating that the smolts grow big and strong very rapidly. When they weigh about two pounds each, the young fishes again change their name. They are now called "grilse"; and not until they are four years old and quite grown up are they really entitled to the proud name of "salmon."

There are many different kinds of these fine fishes, and they have many different names. There is the Atlantic salmon, the Pacific salmon, the blueback, the Chinook or "king salmon," one of the most valuable of all, and the "humpback" and dog salmon, which are not of much account. All live in the cooler seas of the northern parts of the world and ascend the rivers of Europe and Asia as well as those of North America.

There are, too, certain salmon that never go to sea at all. They are called "land-locked salmon," and live most of the year in the deep waters of the big lakes of North America and Europe. Their only journey is to run up the little streams that flow into the lakes,

This young fisherman of the Columbia River has a right to smile, for he has just caught a Chinook salmon weighing forty-seven pounds!

Photo by the Longview Co



## LIFE IN OUR STREAMS AND BROOKS

in order to leave their eggs in the salmon nurseries. These stay-at-home salmon are fine, sporting fishes, but they do not grow so large as their more venturesome relatives who travel such long distances to and from the sea.

### The Wanderlust of the Eel

Another famous fish traveler is the eel, that queer, long, slippery fish that looks

they swim steadily on until they have journeyed far away from land, right out into the deep waters of the ocean.

### The Graveyard of a Grown-up Eel

And there we lose sight of them. For the eels never go home again. They have traveled all those miles simply that they may deposit their eggs in the sea; and when this important duty has been accomplished,



Photo by American Museum of Natural History

This very odd-looking animal has a name almost as long as his nose. He is called the spoon-billed paddlefish, and he lives in the Southern United States, par-

more like some odd kind of water snake than a true fish.

Eels are not summer visitors to inland waters, as the salmon are. They are fresh-water fishes whose real home is in the rivers, lakes, and pools. But every autumn thousands of big glittering eels come wriggling down the streams and rivers on the eastern side of North America and make their way out toward the sea. Because they are so bright and shiny they are often called "silver eels," though they are really only common eels that have changed their ordinary dull green-and-yellow dresses for silvery traveling suits.

### The Nighthawks of the Stream

The eels travel mostly by night. In the daytime they rest, crowded together among the weeds or half buried in the mud at the bottom of the water; then, soon after the sun has set, they go on again.

When they reach the open sea the travelers do not stay around the coast as salmon do;

ticularly in the Mississippi and its tributaries. There he may grow to a length of six feet. With that nose he stirs up mud in the river bottom to find food.

the parent eels all die, somewhere in the sea.

So the eggs are left, quite unprotected, drifting about in mid-ocean. Most of them promptly disappear down the throats of prowling sea creatures. But not all meet with such a tragic end. Some are overlooked by the hungry fishes, and from these, in due time, the wee baby eels are born.

### The Strange Life of an Eel

But what surprising babies they are! No one would ever guess, unless he were told, that these strange little things were young eels. They are not in the least like their long, wriggling parents. They are tiny things, much the shape of a narrow willow leaf and perfectly flat and not much thicker than a sheet of note paper.

At one end each little leaflike creature has an absurdly small head and a wee mouth armed with a few long, needlelike teeth. But it is so small, and so transparent, that when it is in the water you can hardly see it at all. All that is visible is a pair of black



## LIFE IN OUR STREAMS AND BROOKS

dots. These are the eyes, which appear to be floating about by themselves in a most uncanny way.

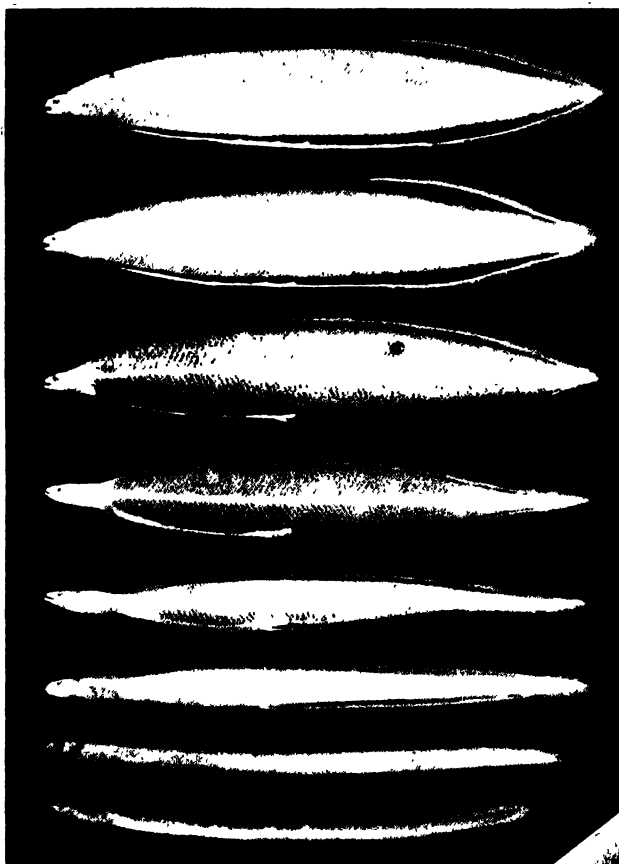
These odd water babies float near the surface of the water and feed on the tiny, almost invisible creatures with which the sea is crowded. But they do not stay long in the middle of the ocean. Almost at once they begin to move away toward the shores from which their parents came.

They have a long, long way to go, and as they are hardly an inch in length when they first set out on their tremendous journey, they cannot, of course, swim very quickly; but the westward-flowing currents in the water help the tiny travelers on their way and carry them along in the right direction.

A whole

year passes before the baby eels reach the coasts of North America or of the West Indies, toward which they have been journeying. By this time they have grown to about three inches in length, though they are still like thin, transparent leaves.

Now, however, they begin to change in shape. They grow shorter and rounder, their needlelike teeth drop out, and when they have completed their surprising transformation they have turned into tiny eels about two and a half inches long.



The eel is one of the strangest of Nature's creatures, and the story of his life is quite as fascinating as any fairy tale. Every year millions of adult eels leave their fresh-water lakes and ponds and streams, all drawn by the same blind instinct toward one spot in the Atlantic, where they will lay their eggs and die. Above are the growth stages of the baby eel, from its first stage as a leaflike body with a tiny head and sharp little teeth to the round-bodied, full-grown eel.

They are still quite transparent, so they are often called "glass eels"; but "elvers" is really their proper name.

The young elvers are now ready for the last stage of their journey. They enter the mouths of the rivers and swim boldly upstream, finding their way into running brooks, lakes, and ponds. Thousands of elvers may be seen in the waterways in the springtime, all twisting and squirming about just as if they were made of rubber tubing.

Photos by British Museum and N. Y. Zoological Society

## LIFE IN OUR STREAMS AND BROOKS

If their way is barred by a dam or a natural fall which they cannot surmount, large parties of young eels will often leave the water at night and wriggle overland through wet grass to a bend in the stream or to an inland pool. For unlike most fishes, eels are able to live quite comfortably out of water for some little time. The thick slime with which their skin is coated and which makes them so slippery keeps the eels moist and cool; and their gill pockets, which look like two swellings, one on each side of the throat, contain a supply of water to enable the fishes to breathe while they are taking a short cut across country.

Fishes, you know, cannot breathe air directly, as land animals do. They take oxygen out of the water with their gills, which look like tufts of very delicate feathers. The water flows through the fish's mouth, over the gills, and out again through little slits on each side of the throat. Gill slits are usually protected by a small fold of skin, called the "gill cover." You may see the gill covers gently opening and shutting as the fishes breathe.

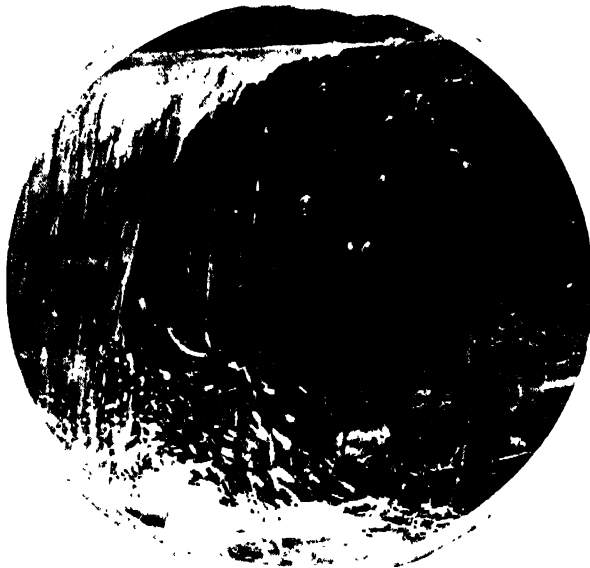
But at last comes a time when the eels have grown as big and as sleek and as strong

as they ever will be. Then, strange to say, they lose their appetites and grow restless. They care no longer for their peaceful home, and something urges them to go back to the deep salt sea where they were hatched and where they spent their infant days. So the big full-grown eels collect together in little companies and away they all go, down the rivers and out into the wide Atlantic, just as their parents did before them.

The European eels are even greater travelers than their American cousins, for they come all the way across the sea to their breeding grounds south of Bermuda. Some of the European and American baby eels must actually meet now and then far out in the middle of the Atlantic. Yet, for some marvelous reason, while the young American eels swim off toward their native shores, the European babies set out in the opposite direction. They enter eastward-flowing currents and are carried away to the coasts of Great Britain and Europe.

Since they have so much farther to go, of course the European eels take longer on their travels. It is nearly four years before they come to the end of their journey and are ready to change into elvers.

We will give you a hundred guesses as to what this picture represents; and it is doubtful if even then you can guess that it shows a number of strange, eellike fishes called lampreys which are climbing the wall of rock behind a waterfall, on their way from the sea to lay their eggs in a stream. The water has been removed.



Lampreys have naked bodies and gristle instead of bones. Their jawless mouths are round, funnel-shaped suckers set with horned teeth. The tongue, too, is toothed. So when a lamprey is hungry, he attaches himself to another fish by his sucker and rasps away with his tongue. In the New York lakes there is a lamprey that never goes to sea.

Photo by American Museum of Natural History

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# ***The STORY of FRESH-WATER LIFE***

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## **Reading Unit No. 5**

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### **SHELL-CLAD FRIENDS OF POND AND STREAM**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

How the crayfish is fitted for earning a living, 3-254-57  
The fairy shrimp, 3-257-58  
How pond snails move, 3-258  
How snails keep ponds clean, 3-259

The stay-at-home mussels, 3-261  
How young mussels get a free ride on fishes, 3-261-62  
Pearls and buttons from mussels, 3-262

#### ***Things to Think About***

How is it that the crayfish can bend in spite of its armor?  
Why do crayfish need two new suits of armor each year?  
How can insects skim along on the surface of a pond?

How many teeth has a pond snail?  
Since the mussel is fixed in one spot, how does it get food?  
How do we get pearl buttons?

#### ***Picture Hunt***

Why is it unnecessary for a crayfish to build a nest? 3-256  
Why do we sometimes find empty crayfish shells? 3-257  
How are dead animals removed by snails? 3-258

How do pearls develop in clams? 3-261  
Why are pearl necklaces expensive? 3-262

#### ***Related Material***

Are any other cave animals blind, as the cave crayfish is? 3-431  
How does the lobster care for her eggs? 3-186

What relative of the crayfish also moults? 3-186-87

#### ***Leisure-time Activities***

PROJECT NO. 1: Capture a few crayfish and put them in a fish tank provided with a cave made out of stones. Feed the crayfish a dead goldfish. Observe and record the behavior of

the crayfish. Include a few pond snails in the tank.

PROJECT NO. 2: If you can find some fresh-water mussels or clams, open them and look for tiny pearls, 3-262

#### ***Summary Statement***

Crayfish look like lobsters and are armored like them. Pond snails are the garbage eaters of

the pond. Mussels suck in water which contains tiny bits of food.

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Photo by Lorus J. and Margery J. Milne

You are looking into a shallow pool, its surface rippled with waves and dappled with petals of flowers. Walking

on the bottom is a big speckled snail. A second snail his big foot uppermost is walking on the surface.

### **SHELL-CLAD FRIENDS *of* POND *and* STREAM**

***The Hermit Crayfish and the Little Fairy Shrimp Take No Chances. They Put on a Stout Coat of Mail; and the Pond Snail Always Carries His House Whenever He Takes a Walk***

**U**NDER a stone, or tucked away in a comfortable hole in a bank, at the water's edge, lies the hermit of the stream--the odd little fresh-water crayfish. All day long he stays at home, gazing solemnly out into the water as if he were deep in thought, his long twitching feelers stretched out in front of him.

Very useful those feelers are. They detect every vibration in the water; so the minute anything approaches his cell the hermit is aware of it and acts accordingly. When a big fish passes by he "lies low." But should a wee fish swim up to the door of his cell, or a water insect wander within his reach, snap goes a big claw--and the hermit enjoys a little light refreshment.

We are more likely to see the crayfish in the evening, when he leaves his retreat in search of something to eat. For although he may indulge in many a nice little snack in the daytime, he does not get nearly enough in this way to satisfy his hunger.

He does not mind much what he has for supper. He will eat worms, insects, snails, frogs, in fact anything he can catch; or he will make a good meal of any dead creature he finds lying at the bottom of the water. And if nothing else is available at the moment, the crayfish munches the leaves and roots of water plants.

While he is busy feeding, the hermit keeps a sharp lookout for any possible danger. His sensitive feelers twitch, and his queer

## LIFE IN OUR STREAMS AND BROOKS

pop eyes, which are set at the ends of short movable stalks, twist and turn about in all directions. At the first alarm he shoots quickly backward through the water and hides himself in the first hole or corner he can find. His chief enemies are big fishes, especially eels, and otters, who crunch him up in spite of the tough suit of armor that clothes his plump little body.

Of course the crayfish is not really a fish. You can tell that at once by his appear-

armed with a pair of big crushing claws, and are used more as arms than legs; this leaves eight legs for walking—which surely ought to be enough. The walking legs are not very stout, and the two front pairs have only small nippers by way of feet, while the last two pairs end in simple spines.

### Extra Legs for Paddles

In addition to all these legs the crayfish has several pairs of paddles, called swimmerets, under his tail, and a large tail fin at the end of it. Then he has two pairs of feelers—one short and one very long pair—and a most extraordinary mouth made up of a great many different parts, some for feeling, some for biting, and some for crushing his food.

The head, the body, the legs, the swimmerets, and even the curious mouth pieces of the crayfish are incased in stiff, horny armor. His head and shoulders are covered with one large piece called the head shield, and behind this come a number of rings, each one slightly overlapping the one behind it. This arrangement allows the crayfish to twist and turn about with ease, while at every joint in

his anatomy the armored covering

ance. He is almost exactly like a small lobster. He is the same shape, has the same number of legs, paddles, and feelers, and his armor is made of the same horny material and fashioned in exactly the same way as a lobster's is fashioned.

He is certainly well provided with legs, for he has no less than five pairs. The first pair, which are very broad and strong, are

The crayfish shown at the right has this basement apartment looking out on a watery "Main Street." If any little fish or frog is ill-advised enough to come and call, it finds him a willing but very greedy host!



Photos by American Museum of Natural History and Cornelia Clarke

## LIFE IN OUR STREAMS AND BROOKS

The female crayfish never has to build a nest. After she has laid her eggs in some hidden burrow where she will not be disturbed, she attaches them securely to the lower part of her body. Even swift currents will not dislodge them.

Wherever she goes, the mother has to take her babies with her. There are sometimes as many as two hundred of them, and it takes them a long time to hatch out of the eggs.



Photo by Cornelia Clarke

is quite thin and soft, so that he has no difficulty in moving his legs and his feelers and his funny

jaws in any way he pleases.

The only inconvenient thing about this wonderful armor is the fact that it does not grow with the growth of its owner. So when his suit becomes uncomfortably tight, the crayfish is obliged to discard it. It cracks down the back, and the crayfish squeezes himself through the opening, pulling out his legs and his tail, his great claws, his long feelers, and all his mouth parts—just as you would pull your fingers out of your glove.

Luckily, however, when this happens a new suit has already formed under the old one, though at first it is quite soft and the poor crayfish is left limp and helpless, at the mercy of any enemy who may chance to find him in this unprotected state. So he stays at home and hides himself from all eyes until his new suit has hardened.

While they are growing, young crayfish are obliged to moult very frequently, but when they are quite grown up, they never have more than two new suits a year. That is to say, the males usually have two changes; the lady crayfish, who is still more economical, is content with

only one. Perhaps her appetite is smaller.

When cold weather sets in, the crayfish retire for the winter to deep holes in the river banks, which they scrape out for themselves with their claws, if they cannot find them ready-made. They are not at all sociable creatures. Even the male and female crayfish do not keep each other company for long. They seek separate winter quarters, where they may live alone in peace and quiet.

As soon as she has settled herself in her solitary burrow, the crayfish lays a batch of one or two hundred eggs and attaches them to her swimmerets. The eggs take a long time to hatch, and the baby crayfish are not ready to come out into the world until late in the following spring or early summer. When they do make their appearance, the funny little creatures, which are already very much like their parents, cling to their mother's swimmerets with their tiny claws; and for some time she carries her large family about with her whenever she walks abroad.

Most of the crayfish are quite small, but big fellows a foot or more in length are found in some of the

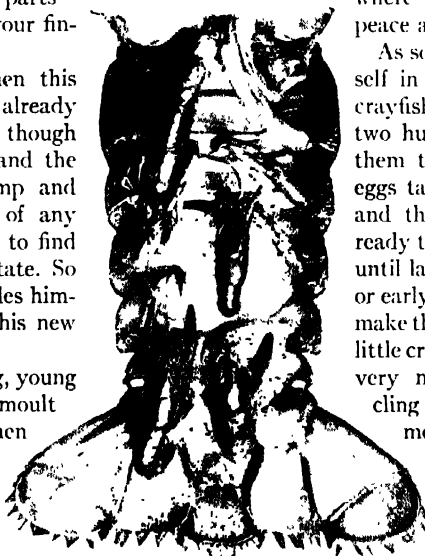


Photo by Cornelia Clarke

After they hatch, the babies, which already look just like their parents, continue to cling to their mother for a long time. You will see four tiny crayfish above.

## LIFE IN OUR STREAMS AND BROOKS

larger rivers; and these are caught, cooked, and eaten just as their sea cousins, the lobsters, are. They are all independent creatures, and in some parts of North America certain crayfish have forsaken the water world and taken to a life on land. There they burrow deeply in damp earth until they reach the ground water below; and you may guess where they are hiding from the heaps of mud, like little chimneys, which they throw up at the top of their burrows.

Sometimes so many of these odd crayfish settle in the same area and erect their mud chimneys so close together that they are a real nuisance—especially when they choose cultivated fields for their mining operations.

In the Mammoth Cave of Kentucky are blind crayfish and blind fishes, too. For if they did have eyes it would do them no good. To make up for the lack, those fish have a very delicate sense of touch, which helps them to find their way about and to get their food.

Many of the smaller inhabitants of the water world retire from active life during the winter months. In the spring and summer, and in the autumn as long as the days are still warm and sunny, we may see ever so many lively little fresh-water shrimps sporting about in the water or sidling over the bottom as they hunt in the mud for something good to eat. But as soon as the days grow chill and the water cold, the shrimps disappear, and you would think they must all be dead. But not a bit of it! They have only put themselves to bed, and are all safely buried in the mud at the bottom of the stream.

There they stay all the winter long, and

come to no harm even should the water be frozen over. But with the first warm days of spring, up they all come again; and if you go down to the waterside you will see the tiny things bustling about, just as excited and lively as ever.

### A Shrimp That Is Not a Shrimp

The fresh-water shrimp is not really a shrimp. True shrimps have only ten legs, like the lobster and the crayfish. The tiny fresh-water fellow has more than this. He

has legs—of different sorts and sizes—on his head and his tail and his body. Some are for clasping, some for walking, some for swimming. Yet, in spite of all these legs, if you take the little creature from the water and place him on the ground, he will wriggle along on his side; and his favorite method of swimming is upside down!

The dainty little fairy shrimp can hardly be said to have any legs at all. Instead it is provided with no less than eleven pairs of paddle feet—like so many transparent leaflets surrounded by a fringe of waving hairs. It is larger than the common fresh-water shrimp, but is so transparent that it is not at all easy to see when it is moving about in the water.

### How Fairy Shrimps Get into Puddles

This little creature is more often to be found in small shallow pools than in running streams; and at times swarms of “water fairies” suddenly appear in the rain-water puddles, where you would least expect to meet them. How they manage to get there seems very mysterious at first, but the truth of the matter is that the eggs from which these “fairies” came were lying dormant in



Photo by Cornelia Clarke

Here is part of the armor of a crayfish; he discarded it when it got to be too tight for him. You can sometimes find pieces like these when you are wading in a brook, or else along the bank, where they have been washed up by the water.

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the dried-up mud—where they may rest for ever so long unharmed—waiting for the magical touch of the water to awaken them to life.

### Sober Little Pond Snails

The sober little pond snails are altogether different in their ways and manners from the sprightly, delicate fairy shrimps. They are solid little people, with compact houses of their own into which they can retire whenever they want to. So there is no occasion for them to put themselves to bed when winter comes. Indeed, so hardy are the pond snails that they are often crawling about serenely when their water world is covered over with a thick white roof of ice.

Naturally one would expect pond snails to live in a pond, and a great many of them do; but you will find them also on the stones and water weeds of any brook or stream where the water is fairly clear and not too rapid.

Water snails are not nearly so dull and uninteresting as many people suppose. Of course they do not dart about like fairy shrimps, but they are fairly active, as a rule, and are often to be seen crawling quite briskly over the water weeds in the pond or stream, or gliding along upside down just below the surface of the water, as easily as a fly walks on the ceiling.

That a snail can cling to the surface of the water, and even creep along beneath it without sinking down, may seem very strange, for of course the top of the water is not solid like a ceiling. But all water is really covered with a delicate film called the "surface film," which

is made up of denser particles of water. This film is so marvelously thin that it is quite invisible to our eyes, but it is there all the same. This surface film, or "skin" of water particles, is always in a state of tension. That is to say, it "exerts a pull"—like a stretched sheet of rubber. It is on the top of this film that the "water striders" skate and the gnats dance so gayly without wetting their tiny feet. To this film, too, the snail clings with its broad foot—and so the mystery is explained.

### A Fresh-water Acrobat

Besides taking an occasional stroll beneath the surface film, many pond snails are fond of amusing themselves by swinging at the end of a rope suspended from the top of the water. The snail first makes its own rope by spinning a thread of mucus a few inches long. The thread hardens on coming in contact with the water, and at the top it is expanded into a little float to keep it steady and to prevent it from sinking down to the bottom of the pond. There the little acrobat hangs, gently swaying backward and forward with the movement of the water, and at intervals climbing up its rope to the surface to take in a fresh supply of air.

Some snails prefer a tight rope instead of a slack one for their gymnastic performances, so they fasten the loose end of the thread to a convenient stone or weed and glide up and down at their ease.

Most pond snails have no gills, as crayfish and shrimps have. They are air breathers like their cousins the land snails. So they are obliged to come up to

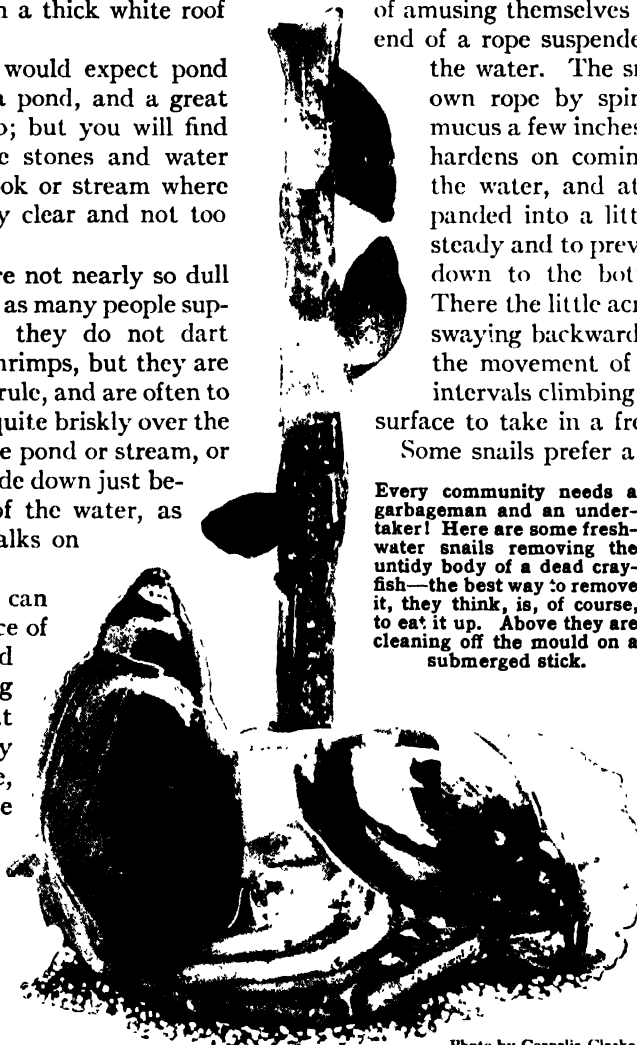


Photo by Cornelia Clarke



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Each of the "curlicues," or whorls, in these snail shells represents a room in the snail's house. The animal did not live in all of them at once, but just in the

largest one, which he added when he grew too big for the one behind it. The three large shells at the right belonged to river snails; those at the left, to pond snails.

the surface to replenish their supply when it is exhausted. They have special little lungs, or air pockets, in which they store a bubble of air, and this lasts them for some time while they are creeping around and feeding under water.

Feeding seems to be the one object in the life of this little shell dweller. As it wanders over the water weeds with its broad head and its two little horns thrust well out of its shell, the pond snail is forever licking and scraping away at the weeds with its rough little tongue. This tongue, by the way, is a perfect rasping tool. It is like a narrow ribbon with rows and rows of tiny hooked teeth, set closely together, all the way down from end to end. No less than 8,343 teeth have been counted on the tongue of one of the larger pond snails!

### Garbage Men of the Stream

Fresh green water weed appears to be the favorite food of most of these little water folk, but they are by no means strict vegetarians. Some pond snails are real scavengers, or garbage men. They will eat any decaying stuff they find in the water, and

even feast on an old newspaper that may have been thrown into the stream by some untidy person. So the snails do good in their own way by helping to dispose of the rubbish in the water, though they are not always quite such innocent creatures as they appear to be. Big pond snails will sometimes kill and eat tiny minnows, sticklebacks, and young newts, while some even devour their own relatives.

### Styles of Snail Houses

There are a great many of these pond snails, and each separate family has its own particular style of residence. Some shells have long twisted spires, others are decorated merely with a little round button on top, and some are flat and coiled round and round—these are called "trumpet snails" or "ram's horns." And while many shells are all one color—plain brown, yellow, or dark purple—others are ornamented with wavy bands or checkered patterns of some contrasting shade, and are really most pretty little things.

A snail's shell is one of the most convenient kinds of house. Not only can its

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owner carry it about on its back wherever it goes, and retire indoors without waste of time at the first hint of danger, but as the snail grows, its house grows too. So the neat little dwelling is always the right size, and there is no occasion to move into a larger one. This is just as well, as a snail could not possibly move out of its house, however much it wished to; for the shell is actually a living part of the little animal.

### The Fresh-water Limpet

Most pond snails prefer clear ponds or gentle streams, though some are quite at home in stagnant water and muddy ditches. But the little fresh-water limpet is happiest in swiftly flowing water, where it wanders over the stones at the bottom, busily scraping away at the weeds and moss. Several of these hardy little creatures are often to be seen clustering together on the rocks under a cascade, quite enjoying the rush and tumble of the swirling waters. The fresh-water limpet is a tiny little creature, and its pale-yellowish, tent-shaped shell is very much like the shells of the true limpets that cling so fast to the rocks on the seashore—although really it is not related to them at all.

Although they can tuck themselves right away inside their shells when they want to, neither the

pond snail nor the fresh-water limpet is able to close the entrance to its house when it is at home. But the big river snail has a useful front door, made of horn, which exactly fits the mouth of his shell and shuts out all unwelcome visitors. The door is fixed to the snail's broad foot, so he has only to push his foot out or pull it in to open or close the door.

Pond snails deposit their eggs on plants or stems in long ribbons of jelly, but the river snail keeps her eggs inside her shell until they are hatched. When they first make their appearance in the water world, the young river snails have rough, bristly shells; but as they grow older the little bristles fall off and their shells become smooth just like their parents'.

### The Dull Life of a Mussel

Water snails do move about and see life, but some of the fresh-water mussels would seem to have a very dull time of it. Winter and summer alike they spend their days half buried in the mud at the bottom of the river. Yet one would hardly think the river mussel need be quite so cautious

The fisherman trails these strings, weighted with lead, at the bottom of a river where clams are feeding, with their shells open. When the clam feels the cold lead, he closes his shell upon it and can easily be pulled to the surface.



Photo by Cornelia Clark

## LIFE IN OUR STREAMS AND BROOKS

as all this, for it has a strong double shell of its own, which shuts up like a box to protect the tiny shellfish inside it.

### How a Mussel Gets Its Food

The mussel is a singular creature in every way. It has no distinct head, as the snails have, no tongue, no jaws to bite with. In fact it is little more than a plump

body with a mouth at one end and breathing gills down each side. It is wrapped up in a soft, thick shawl, or mantle. But it has a foot, and a very useful one too, which can be used either for spading or for shuffling along the ground when the mussel wishes to change its quarters. With this foot the mussel digs itself in, leaving just the tip of its shell sticking up above ground in the open water.

Now how do you think the mussel gets its food down there in the mud? It cannot hunt around for it, as the snail does. No, it just stays still, opens its shell a little way, and sucks down the microscopic creatures and tiny fragments of weed that are always floating around in the water. The edge of its mantle curls round to form two little funnels, fringed with fine hairs. The fringe waves over the top of the shell, causing a current of water to flow down one funnel and up the other; and the water carries food

to the mouth and oxygen to the gills of the strange little animal down below.

One of the most interesting of these mud dwellers is the big swan mussel, which has a greenish-yellow shell, decorated with brown lines, and a large yellow foot. Large quantities of swan mussels often crowd side by side in the mud, some of the oldest members of the little community measuring nine inches or more from end to end.

Most shell dwellers have very large families, and the swan mussel is no exception to the rule. The eggs, about three hundred thousand of them, are kept close within the parent's shell until they hatch, and then the baby mussels are carried out into the world by the outgoing currents of water. Although

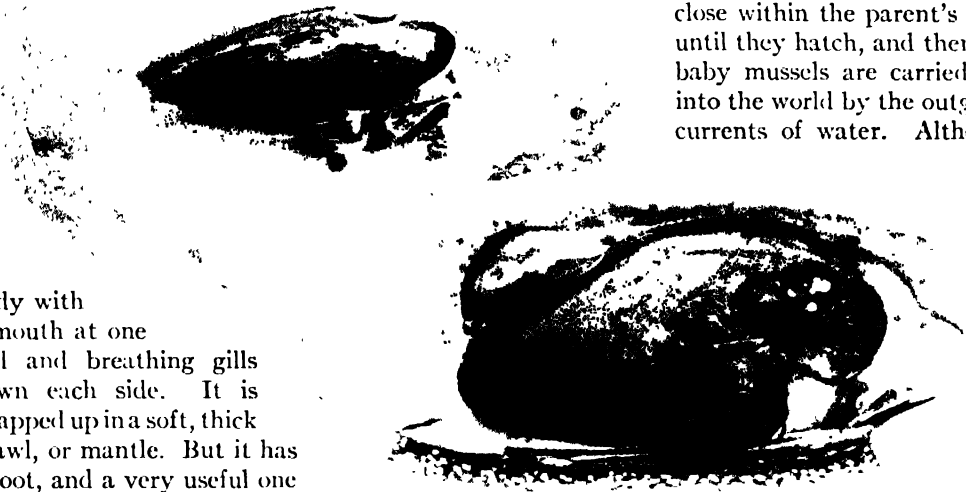


Photo by Cornelia Clarke

Above is a clam ploughing his way through the soft mud with the aid of his foot, which he has thrust out of the half-opened shell. Below him is a clam which has produced a pearl by covering a grain of sand with mucus. The clam dies when his shell is broken open in this way.

it is so small that it looks like a mere speck in the water, each little creature has a wee double shell, each half of which is armed with a stout hook or spike on its edge.

As soon as they are free the young swan mussels begin swimming about in the water, jerking themselves along by opening their little shells and clapping them smartly together again. Sooner or later most of the tiny things are sure to bump up against a fish, and at once they stick their hooks into its fins or gill covers and cling with might and main. For weeks the fishes that have been caught in this way are forced to carry their little passengers about with them. Then the young mussels drop off and bury themselves in the mud wherever they happen to find themselves.

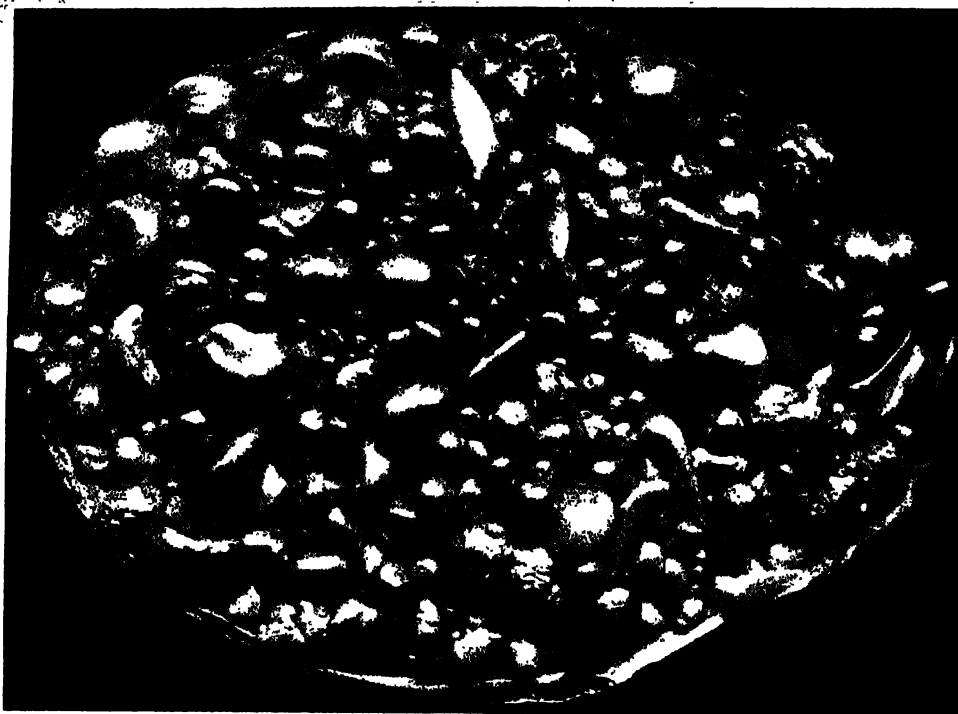


Photo by Cornelia Clarke

Here are three thousand dollars worth of pearls and slugs taken out of clams that grew in the Mississippi River, where fresh-water mussels abound. Some of these are valuable and some are not, depending upon their color, size, shape, and luster. You can see how great a variety there is among them. A few will have the perfect globular or pear-shaped form that belongs to the most valuable pearls. Still fewer will have the clear white coloring and sheen that buyers of pearls want. And fewer still will combine these qualities with size. A really fine pearl is very rare. But that does not mean that there are not a good many pearls in this lot that almost anyone would delight to have in

a pin or a necklace. Many of them are very beautiful indeed, of graceful shape and exquisite coloring—soft pink, a delicate cream color, lavender, or purple. And how much easier they are to get than salt-water pearls! Searching for them is fun, even for a child. From June to October whole families flock to the banks of the Mississippi and its tributary streams, especially in Iowa, and spend the summer days fishing for clams and opening the catch along the shore. Sometimes a merry party takes a house boat, and in this way spends a profitable holiday—for no matter how poor your luck may be in pearls, you always have the shells to sell to the button factory!

So by this means the swarms of young swan mussels are scattered in all directions and are often carried long distances away from the place of their birth. This is just what is wanted. For it would never do for all the young mussels to settle down in a mass beside their parents. Only think what a crush there would be if they all set up housekeeping so close together.

## Where Pearl Buttons Come From

Baby pearl mussels—or fresh-water oysters, as they are sometimes called—behave in much the same way as the young swan mussels. Pearl mussels are rather im-

portant to us. From the lovely mother-of-pearl lining of their rough-looking shells, pearl buttons are manufactured, and sometimes quite valuable pearls are found inside them. Swan mussels also produce pearls occasionally, but this may happen now and then to any shell dweller that boasts a pearly lining to its shell.

Fresh-water mussels do not all bury themselves in the mud. Some, like their sea cousins that cluster on the rocks on the seashore, spin a bunch of strong threads called a beard, and with this, anchor themselves to stones or logs or anything handy in the flowing streams.

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# **CENTIPEDES *and* MILLEPEDES**

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## **Reading Unit No. 1**

### **CREATURES WITH MANY LEGS**

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### ***Interesting Facts Explained***

Where to look for centipedes and millepedes, 3-264

How centipedes are made, 3-264-66

How centipedes hunt and kill their prey, 3-266

How centipede eggs are protected, 3-266-67

How millepedes behave when disturbed, 3-267

How mother millepedes build egg nests, 3-267

#### ***Things to Think About***

How do centipedes run?

How can centipedes kill animals larger than themselves?

How do millepedes defend themselves?

How is a millepede egg nest constructed?

What is a myriapod?

#### ***Picture Hunt***

Should centipedes be killed at sight? 3-264

Has a centipede a hundred legs? 3-264

Of what use is a tent to a millepede? 3-265

How does a millepede protect her eggs? 3-266

#### ***Related Material***

How do some spiders protect their eggs? 3-406-10

What spider has a poisonous bite? 3-410

#### ***Leisure-time Activities***

PROJECT NO. 1: Count the number of legs on several centipedes. How many are there? 3-265

PROJECT NO. 2: Pick up a millepede from under a rock. How does it behave? Can you smell its defensive fluid? 3-267

PROJECT NO. 3: See if you can find centipedes under bark of logs and under stones. Place them in a jar of earth encircled by a broad band of wrapping paper to keep it dark. Feed the centipedes live roaches and other insects. Observe their habits.

#### ***Summary Statement***

The hundred-leggers prefer the dark and can be found under stones and logs. Centipedes are beasts of prey and eat many in-

sects after paralyzing them with a bite. Millepedes usually roll up when disturbed and give out a strong odor.

## CENTIPEDES AND MILLEPEDES

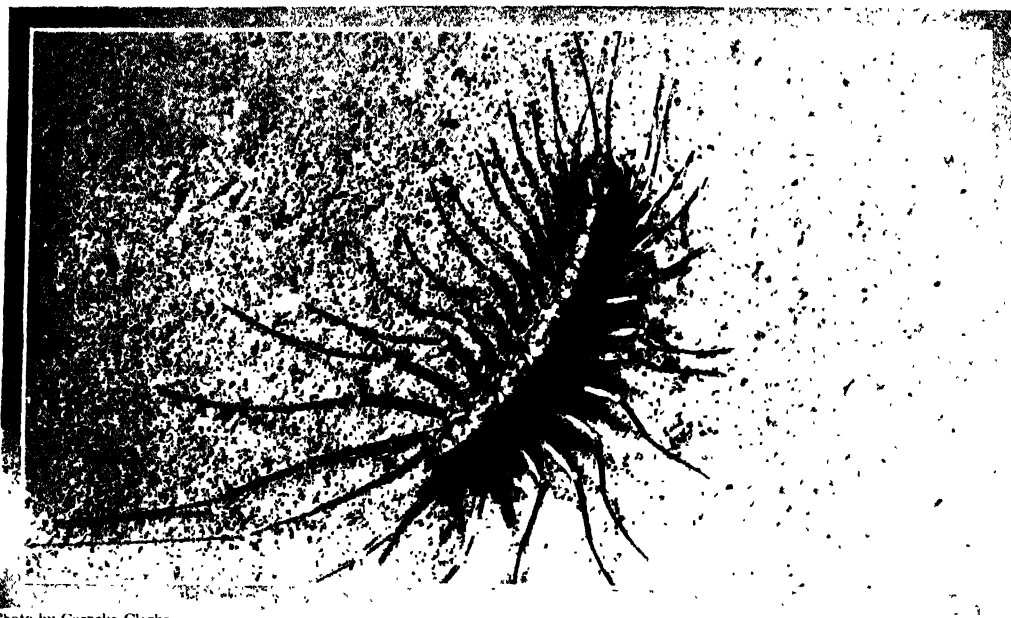


Photo by Cornelia Clarke

You have probably seen this odd little fellow some summer evening scuttling away when you moved a box of apples or a bag of potatoes in the cellar; for

he is the common house centipede. He is quite harmless, and even does you a good turn by feeding on flies and other annoying insect pests.

### CREATURES *with* MANY LEGS

*This Story Will Tell You about a Strange and Very Interesting Tribe in the Great Animal Kingdom*

**I**F WE turn up a big stone lying half buried in soft earth, or stir up a heap of moldering leaves by the wayside, we are almost certain to disturb a whole colony of queer wriggling creatures that love darkness better than light. And it will be strange if among them we do not find a few hundred-footers, as well as some of their nearest allies, the thousand-footers—or Millepedes (míl'ê-pêd)--who rejoice in an even greater number of legs.

"A Centipede was happy quite  
Until a Toad in fun  
Said, "Pray which leg moves after which?"  
This raised her doubts to such a pitch  
She fell exhausted in the ditch,  
Not knowing how to run."

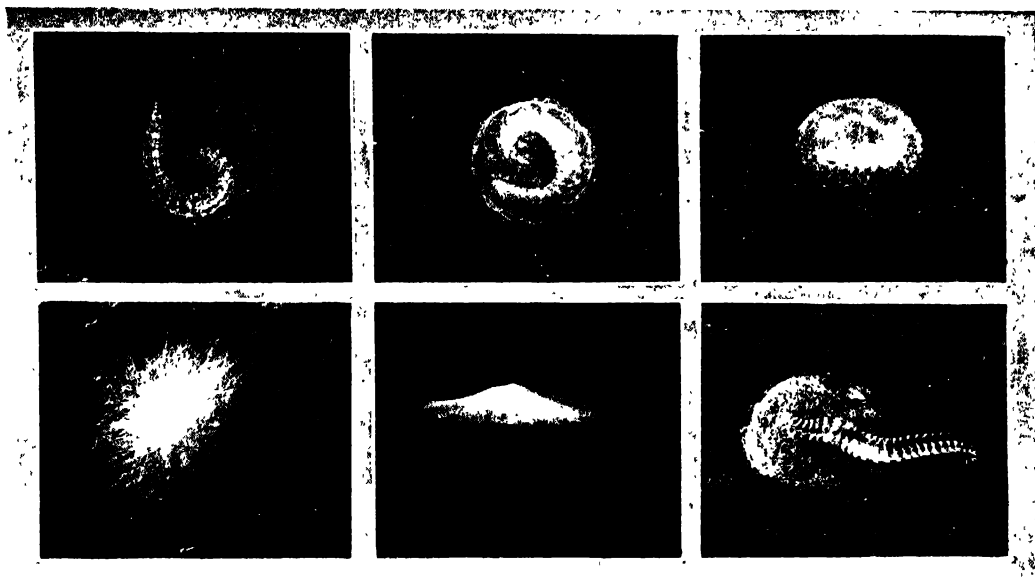
Just how the centipede (sên'tl-pêd) runs has puzzled a good many people. For the

odd little animal scuttles over the ground, with its "hundred legs" going at such a rate that it is next to impossible to see "which moves after which." But that is not the only interesting thing about this many-legged family.

We may quickly distinguish the centipedes from the rest of the wriggling crowd by their legs and their fussy behavior. Like all dim-sighted creatures they hate being suddenly exposed to the full light of day; and, unless there is a handy crack into which they can immediately squeeze themselves, they will dash off as fast as their many legs will carry them to find another hiding place.

Centipedes seem rather to row themselves along the ground than to run in the usual manner, the two rows of legs working like the oars of an ancient galley boat. If you stop their wild career by putting an obstacle in front of them, the adroit little creatures

## CENTIPEDES AND MILLEPEDES



Photos by Hugh Main

Certain millepedes are accomplished tent makers, as you can see for yourself by examining these pictures. They make their tents out of soft silk, like that in spider webs and insect cocoons. Sometimes a millepede will curl up inside, like the one at the upper left, and moult his skin—which he then proceeds to eat. Such a tent is shown in the other pictures on

the top row. Sometimes the millepede's tent, like the one shown from the top and the side in the bottom row, is meant to house a batch of eggs. In either case, when the millepede wants to get out he eats a hole in his tent, crawls out, and then comes back, like the one at the lower right, to finish his meal. He has literally eaten himself out of house and home!

reverse engines and run backward like shunting locomotives; while if you touch one with your finger, it will turn round and give you a sharp nip with a pair of sharp poison claws which it carries just under its mouth. These claws are really the creature's first pair of legs, which are turned forward, and act as an extra pair of jaws. The "bite" of an ordinary little centipede, such as you are likely to meet with in the garden or a country lane, will do you no harm. But the giant centipedes of hot tropical countries are really dangerous to encounter. Some of them are over a foot long, and a nip from the poison claws of one of these bad-tempered fellows is not only extremely painful but often makes people feel very ill.

### How Many Feet Has a Centipede?

In spite of their name, very few centipedes have exactly fifty pairs of feet. Some have only fifteen pairs, and others as many as a hundred and seventy-three. It all depends on the length of the creature, as its legs correspond in number to the number of rings which make up its wriggly body. Some

of the tropical centipedes are brilliantly colored, while a few shine with a luminescent (lū'mī-nēs'ēnt) light which leaves a glowing trail behind them as they zigzag quickly over the ground in the darkness at night.

### How to Recognize a Centipede

Most of these many-footed creatures, however, are not at all attractive. As a rule they are ugly, dull-looking things, or the color of rusty iron. They are of all sizes, from the giant centipede twelve or fourteen inches long to tiny things you can hardly see without a magnifying glass. Some are long and thin and wiry, others are quite short and broad; some have short legs, some have long legs.

But no matter whether they are long or short, broad or narrow, and no matter how many legs they have, all centipedes are formed on exactly the same plan. The body of the animal is made up of a varying number of somewhat flattened rings. They are all much of a size, and are fitted together in such a way that they can twist and turn

## CENTIPEDES AND MILLEPEDES

and wriggle about in any way they please. Each ring carries a single pair of legs; and the round flat head has a mouth armed with two or three pairs of biting jaws—in addition to the poisonous foot jaws—and a pair of long, jointed feelers. These feelers are very sensitive and act as guiders. With their help the centipedes find their way about and recognize friend or foe; for although as a rule these curious creatures possess more than one pair of eyes, these eyes are merely simple light spots, not of much use to see with, and some centipedes that live in dark caves are quite blind, for they never see the light.

On the other hand, in many of the warmer parts of the world there are certain kinds of centipedes, with very spidery legs, who have quite large compound eyes and can see remarkably well. These odd little animals are very brisk and lively. Instead of skulking in dark cracks or burying themselves in the mold, as most hundred-footers do, they are out and about at all hours of the day and may be seen scuttling over the stones on the ground or running up and down the walls of houses in the full glare of the sun.

### Tiny Warriors that Fight to Kill

Centipedes are savage little beasts, always on the warpath. If two happen to meet when they are out hunting for food, as often as not they dart at each other and begin to fight furiously. Clinching with their poison claws, they nip and bite one another for all they are worth, while they lash round

frantically with their long wriggling bodies. They hunt down and kill worms and crawling things of all sorts. Even winged insects that settle on the ground are caught and devoured by the greedy little brutes. A centipede hardly more than an inch long will slither up to a bluebottle fly that has alighted near and seize the fly with its poison claws before the creature has time to spread its wings and fly away. One nip and the fly is dead—as quickly as if it had been struck by lightning!

The centipede's victims are usually killed or paralyzed almost at once by

the poison injected into them. But sometimes a big worm will turn and lash out convulsively at its enemy, and the two creatures, coiled round and round one another,

will wriggle and roll about together madly upon the ground. But the centipede is sure to get the best of it. The worm may wrench itself free from its tormentor, but it usually leaves a large bit of itself in the jaws of the centipede, who calmly proceeds to enjoy its meal while all that is left of the worm crawls sadly away.

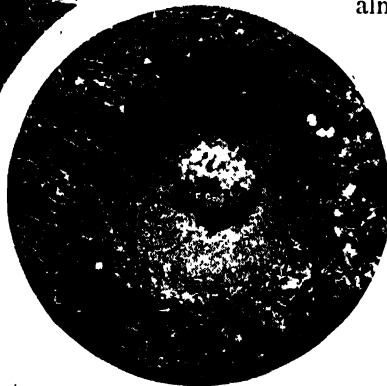
However, the worm may recover from its wounds, even if it has been very badly mauled by the centipede. For these lowly creatures have wonderful powers of recovery. Even if an earthworm is cut in two, the head half will often grow a new tail!

Centipedes are hatched from eggs. But if a male centipede should chance to see an egg lying on the ground he will at once devour it—and that's that! So to prevent such a misfortune befalling her eggs, a female centipede usually hides them as soon as they are laid. Then she goes off and leaves them to their fate. One small centipede, called "Lithobius" (li-thō'bi-ūs), or "thirty-



Photos by Hugh M. ...

Like the female *Julus*, the *Polydesmus*, another of the millepedes, another of the millepedes, builds a snug earthen nest for her eggs. In the square we see her eating earth, which she moistens with a special fluid and moulds into pellets to build her round cell. In the circle we see the nest almost completed and the eggs in place.





## CENTIPEDES AND MILLEPEDES

legs," conceals her eggs in a very curious way. She is one of the commonest kinds of centipede, and may be seen in almost every garden or country lane. Directly little thirty-legs lays an egg, she clasps it firmly with two little hooks at the tail end of her body and dashes off with it at top speed. Then when she reaches a spot where none of her friends or relatives are prowling about, she stops and rolls the tiny egg, which is very sticky, round and round in the soil until it is coated all over with earth. When she has finished with it the egg looks like a little mud pill, which not even a greedy centipede would feel inclined to swallow.

### The Strange "Thousand-Footers"

Millepedes, or "thousand-footers," differ from centipedes in many ways, although like them they are many-legged, many-ringed wrigglers that live under stones or burrow in loose soil. Millepedes are more wormlike. Their bodies are rounded instead of being flattened. They have no poison claws; and on every body ring a millepede has two pairs of legs instead of only one. But having twice as many legs as centipedes have does not make the millepedes run twice as fast. They move in a slow, lazy way, unless they are especially in a hurry, when they slither over the ground quickly enough. Their legs are remarkably small and delicate, and look like a double row of fine fringes which move in a rippling, wavelike fashion as the millepedes row themselves gracefully over the ground.

A millepede is a perfectly harmless creature. If you touch it, it doesn't attempt to bite you, as a centipede does, but immediately coils itself up in a tight spiral, like a watchspring.

### How the Millepede Defends Itself.

But although it does not bite, the millepede has another, and most unpleasant, way of defending itself or expressing its displeasure when annoyed. For when it is handled, or attacked by an enemy, the little creature at once retaliates by discharging a horrid, oily, evil-smelling fluid through the pores of its skin.

One of the commonest kinds of millepede, both in North America and in the more temperate parts of Europe, is the little *Julus*—a small dark brown, wormlike creature hardly more than an inch long. It is often to be found under stones in the garden beds.

The female *Julus* is a most careful mother. And although, as millepedes are not cannibals, there is no fear of her own relatives eating her eggs, she takes even more trouble than little thirty-legs to hide her pigmy eggs.

### The *Julus* Builds a Dainty Crib

Before she lays her eggs a female *Julus* burrows down into the mold a little way below the surface, and there she sets to work to make a neat little nest in a most ingenious way. She moistens little pellets of earth with a sticky fluid from her mouth and, with her jaws and front legs, she works them up into tiny mud bricks of convenient size and shape for her purpose. One by one the *Julus* places her pellets in position, gradually building up the walls of her nest until she has made a mud ball about the size of a small hazelnut. The ball is hollow, and beautifully smooth inside, while the outside is left rough, showing the shape of the tiny bricks of which it is made quite distinctly.

Sixty or a hundred tiny white eggs are packed inside the nest before it is cased up; and the mother *Julus* thoughtfully leaves a small hole in the top of it, as a sort of chimney, through which the baby millepedes can make their escape when they are hatched. Then, her duty done, the *Julus* goes off and takes no further interest in the welfare of her family.

Centipedes and millepedes breathe, as insects do, through breathing pores in the skin. But they are not insects. The number of their legs tells us that—for no insect, except while it is a grub or a caterpillar ever has more or less than six legs. They form a class by themselves in the animal kingdom, and are called "myriapods" (mī'rī-ā-pōd)—which is really a very good name for these many-legged creatures, for it means "having ten thousand feet." You will find centipedes and millepedes of some kind in almost all parts of the world.

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# WONDERS of the INSECT WORLD

## Reading Unit No. 1

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### SWARMS OF MIDGETS WITH SIX LEGS

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Swarms of insects and their way of living, 3-269-71  
How insects help mankind, 3-271-72

How insects help plants make seeds and fruits, 3-271-73  
How insects differ from other animals, 3-273-74

#### *Things to Think About*

How many kinds of insects are there?  
What damage is caused by certain insects?

How can you distinguish between spiders and insects?  
How does an insect breathe?

#### *Picture Hunt*

What must happen to a tiger moth's eggs before they become adults? 3-270  
How does pollen get from one flower to another? 3-271

How can a house fly see in all directions? 3-273  
When do dragon flies have no wings? 3-274

#### *Related Material*

What happens during and after the pollination of a flower? 2-107-13

How is breathing accomplished in man, fish, insects, and plants? 2-334

#### *Leisure-time Activities*

PROJECT NO. 1: Look carefully on plants to find the eggs of insects. Examine the eggs with a lens or microscope. 3-274, 277

PROJECT NO. 2: To learn what pollen is, remove the stamens from any flower, crush them on a glass slide, cover with a cover

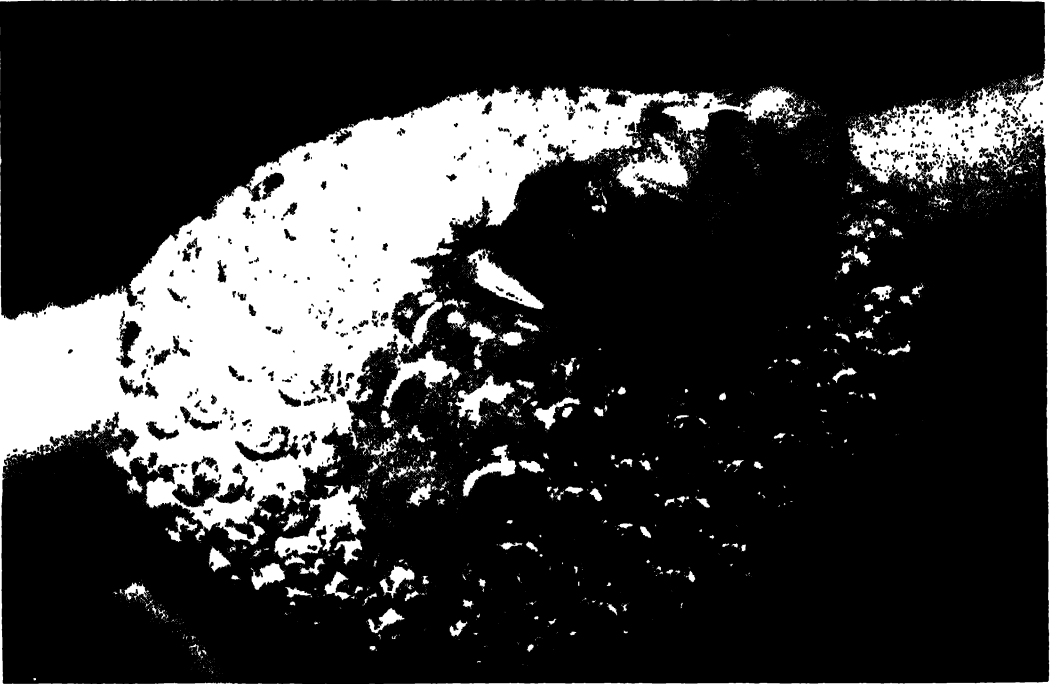
slip, and examine with your microscope. 2-112

PROJECT NO. 3: To study a fly's eye, kill a house fly, and with a razor peel off the brown "skin" of an eye. Examine under a microscope. The same thing may be done to a butterfly. 3-273

#### *Summary Statement*

Insects are animals with six legs. Over a million species have been found. Some are harmful; many are very useful. Insects visit flowers for nectar and pollen.

In this way pollen is deposited on distant flowers so that seeds may form. Without insects most of our fruits and seeds would never develop.



Photograph from Edwin Way Teale

In summer your eye has sometimes been caught by a blob of what looks like spit clinging to the stem of a plant. It is really the retreat of the tiny spittle insect,

or froghopper—greatly enlarged above. He lives on the sap of the plant and from it blows the bubbles which protect him while he grows and develops his wings.

## SWARMS of MIDGETS *with* SIX LEGS

*Creeping, Crawling, Flying, or Digging, They Breathe through the Slits in Their Sides*

**N**OT so very long ago it was the fashion for ladies to scream at sight of a little worm. Not that they thought it could hurt them! They were merely trying to show how refined they were—for all little creeping things were thought disgusting, however gentle, and were always stepped on by ladies who were unusually brave.

Nowadays we know better, and little Miss Muffet's behavior has come to be a joke. We have found out that she was only ignorant and silly, for spiders are among the most interesting and useful of all the tiny creatures that tread the earth—as knowing as the ant or the bee or the busy, blustering wasp, who is such a capable carpenter and construction engineer.

So our great-grandmothers missed a good deal by not knowing what was going on

around them. Anyone with his eyes open and his wits about him can find more real excitement in watching a spider trapping flies than in the fiercest battle ever staged upon the screen. And the little people that creep and hop and fly and burrow are often among the most beautiful of living things.

They are mostly so very small that we may pass them by without ever seeing them. But tiny as they are, they are very important; and there are such vast armies of them that they far outnumber all other kinds of animals living on the earth. No one knows exactly how many different kinds of insects there are, for new ones are always being discovered; but there must be at least a million different sorts.

They creep and fly and hum in the forests.

## WONDERS OF THE INSECT WORLD

lanes, and meadows, crawl and swim in the pools and streams, and dance over the surface of the water. All day long butterflies flit from flower to flower; bees bustle about gathering honey and pollen; fussy little beetles run very fast over the ground and climb up and down the tall grass stems; grubs and caterpillars without number

the dark forests and over the meadows. For Nature never rests. When the sunshine lovers are sleeping, the shy creatures who have slumbered away the hot hours wake up and move about in the stillness of the night.

Nearly everywhere in the world there are some of these wonderful little beings scam-

Did ever a child change more as it grew? From one of those tiny eggs in the circle there hatched the hairy caterpillar you see just to the left of the eggs. He is dressed for protection, for his strong bristles break the force of many a fall and lead a hungry bird to think twice before it gobbles him up. As a caterpillar, our friend eats and eats and grows and grows; and when he has done all the growing he ever intends to do, he makes for himself the hairy cocoon that you see just below him. In that he shuts himself up and turns into the strange, smooth affair shown at the right of the cocoon; it is called a chrysalis. In two or three weeks he will be able to step out into the world as the vestal tiger moth that you see below at the right.



Photo by Cornelia Clarke

munch away at the green leaves on the plants and trees; and gauzy-winged flies buzz gaily about in the sunshine.

When evening comes, the insect folk who have worked and played and fed all through the long summer day settle themselves for the night. Flies stop buzzing and dancing, butterflies fold their wings and go to sleep among the flowers, and busy bees hurry home to bed.

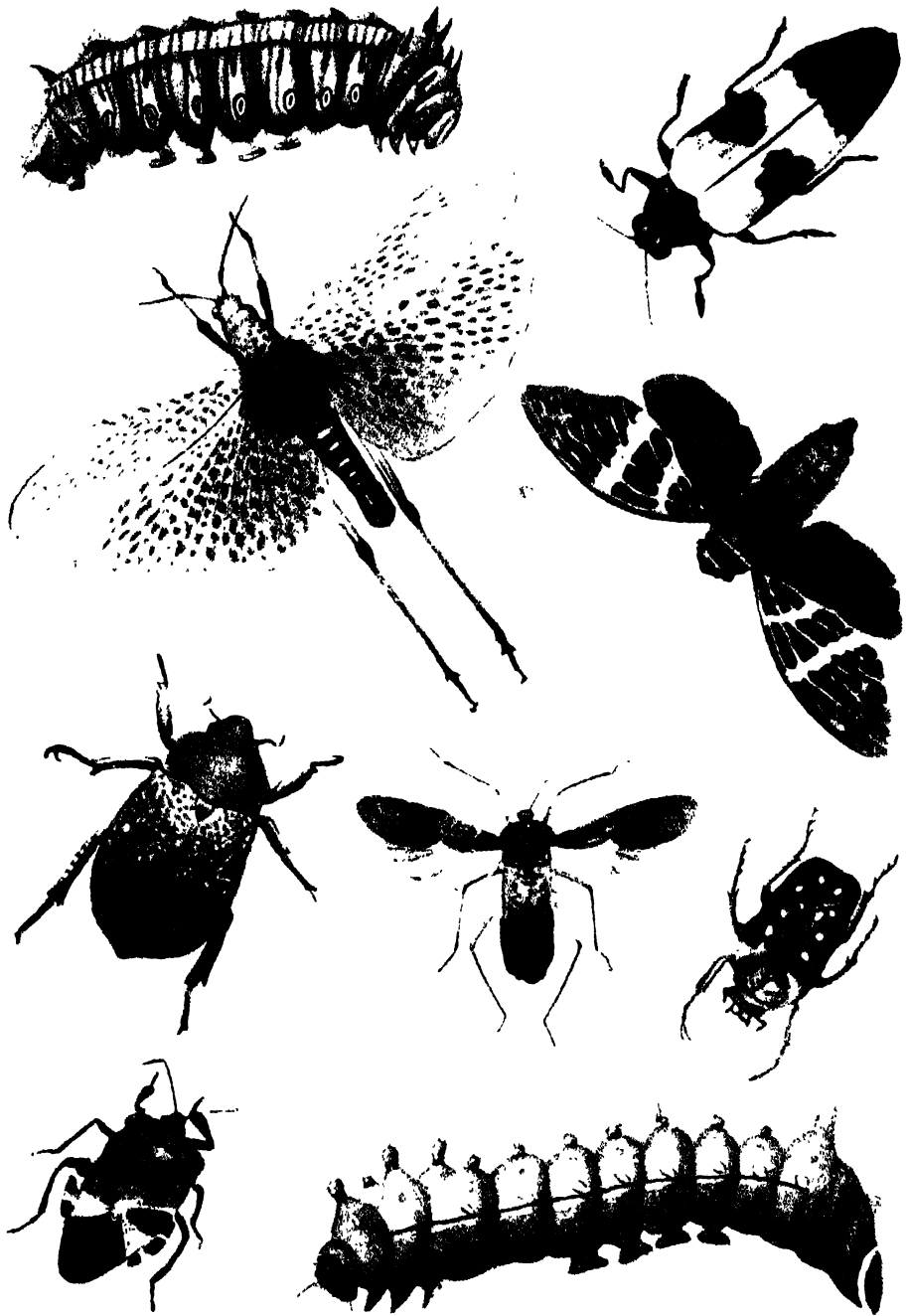
### Night Owls of the Insect World

Then the night-flying moths and beetles and all sorts of queer little creatures come out and flit about in the dark. Glowworms light up their lamps under the hedgerows, and fireflies dart like shooting stars through

bling for a living. Only in the Polar regions, where from year's end to year's end the snow and ice never melt, and in the heart of burning deserts, where every living thing is shriveled up by the scorching sun, are there no insects at all.

Swarms of winged insects fly over the frozen seas to the icebound coasts of the far north, where they tease the reindeer and worry the Eskimos. Some even spend the best part of their lives buried deep under the snow on the tops of high mountains. But it is in hot, tropical lands that the little

## WONDERS OF THE INSECT WORLD



*These brilliant folk go on their way without arousing much interest among any but the learned. Yet they are so beautiful that many a jeweler might do well to copy them—if he could—and their lives contain*

*crises as startling as any drama. If you ever find a handsome caterpillar, take him up gently, put him in a well-ventilated box, with plenty of fresh leaves and drops of water—and wait!*



## WONDERS OF THE INSECT WORLD

The great dragon at the left is only a magnified honeybee that has dusted himself with pollen. He will now carry those fine grains from flower to flower as he gathers his honey, and in so doing will help the blossoms to form their seeds. Some plants, such as the milkweed at the left, have developed clever devices for making the bees serve them in this way.

The well-meaning bee above poked his feet too far into a milkweed flower and found that he was caught in a clever trap that shut up tight and would not let him go.

Photo by Cornelius Clarke

folk are found in the greatest numbers. There, too, they are bigger and more brilliantly colored than in more temperate climates; for insects revel in warmth and sunshine and many compete with the gorgeous tropical flowers in the splendor of their coloring.

### The Wise and the Foolish

There are all sorts and conditions of insect folk. Each little fellow goes about his business and lives his life in his own peculiar way. Some are idle and some are industrious, some are wise and some are foolish—just as human folk are. Some build wonderful cities in which they live and work together in a most intelligent way. Fierce insect clans make war on one another, and

the victors carry off the children of their foes and make slaves of them.

### Insect Friends and Enemies

Some kinds of insects are terribly troublesome. They bite us and sting us, worry our cattle, ruin our crops, and damage our property; and worse still, they carry the germs of diseases wherever they go. Others are friendly little fellows, always working, though they may not know it, for our good. They help to fertilize the soil, clear away decaying rubbish, check the growth of plants that would choke the ground, and are our most valuable allies in fighting and keeping down the vast numbers of our insect foes.

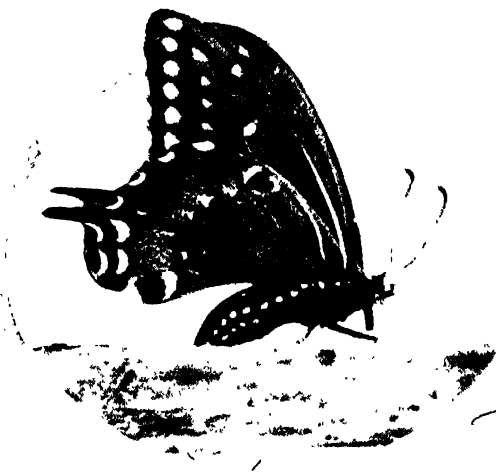
But most important of all are the busy little insects that all through the spring and

## WONDERS OF THE INSECT WORLD

summer fly from flower to flower carrying the precious pollen dust needed to form seeds—for the seeds of many flowers cannot ripen without the pollen from another flower of the same kind. Some of the pollen is

services that the buds keep stores of sweet nectar hidden away in secret cups or pockets which only the long tongues of the bees can reach. When a blossom unfurls its bright petals and gives out a sweet scent, the bees know it has nectar for sale. So they come hurrying up, dive into the flower to sip the honey, and then fly away, with their hairy little bodies dusted with the golden pollen, to other flowers where some of it is rubbed off.

Some of the flowers, however, are not quite



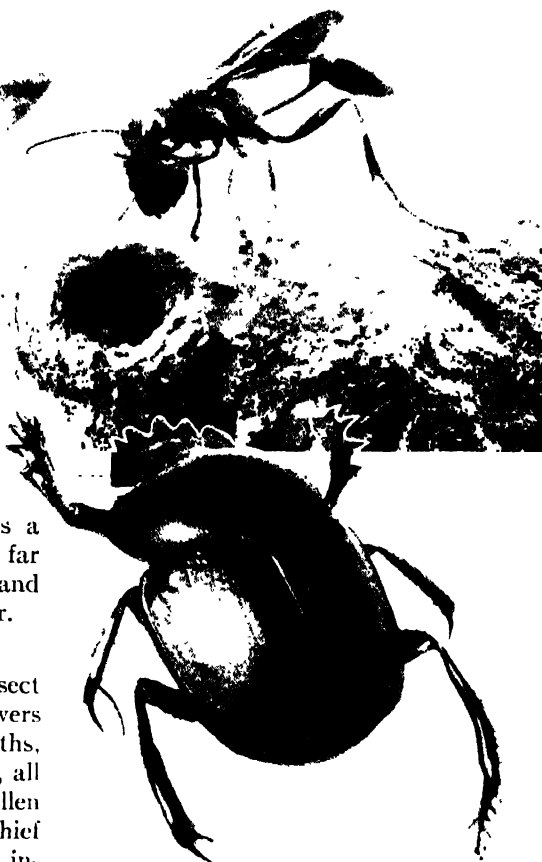
How different they look, and yet they all are insects! Up at the top is one of our light-hearted butterfly friends that jewel every meadow. Below her is the strange mud-dauber wasp, who is busily making her nest with pellets of earth like the one she is carrying. Her waist is so long and thin that it is hardly more than a hair. The strange, lumbering affair below is not to be taken lightly, for he is the scarab that once was worshiped by the Egyptians.

But he is only a beetle just the same.

carried by the wind. But the wind is a careless worker. He scatters the pollen far and wide, so that a great deal is wasted and never reaches the blossoms it is meant for.

### How Insects Help the Plants

If it were not for the help of our insect friends, we should have few bright flowers and very little fruit. Butterflies and moths, and certain of the flies and little beetles, all assist in the good work of taking pollen from one blossom to another. But the chief carriers are the bees. They are most industrious, trustworthy little creatures. They can always be counted on to do their work right. So some of the plants do all in their power to attract the bees and induce them to act as their messengers. It is to catch their eye that the flowers put on their vivid colors, and it is to reward them for their



Photos by Cornelia Clarke and F. Martin Duncan

so careful. They keep the honey in open cups from which all comers may help themselves, and simply trust that some of the pollen will be carried to the right address. Honey is the favorite food of a host of little insect folk, and pollen is another; so flowers



## WONDERS OF THE INSECT WORLD

and insects are about equally necessary to each other. Bees and many other insects could not live without honey and pollen, and many of the pretty flowering plants would die out if there were no insects to help them make their seeds. Of course neither the insects nor the flowers understand what they are doing. They work together unconsciously, helping, all the same, to keep the earth fertile and beautiful.

Now before we venture closer to the strange little beings of the insect world, it will be just as well to make sure that we know an insect when we see it. For there are many other small creatures we might easily mistake for insects if we had not some way of telling them apart. But if we remember that a true and "perfect" insect, no matter of what sort or size or shape it may be, always has six legs, and only six, we shall not often make a mistake. Spiders and scorpions have eight legs, worms have none, and centipedes may boast a hundred legs or more. This tells us at once that the creatures are not insects. So the first thing to do when you meet with a puzzling little animal and are not quite sure whether it is an insect or not is to count its legs. Caterpillars, grubs, and maggots may have more than six legs or may have none at all, but they are baby insects, not "perfect" insects. When they grow up into butterflies, bees, beetles, or flies, they will all have six legs—no more and no less.

Insects are really very curious little animals. For one thing, they have no bones. They wear their skeletons outside, so to speak, in the shape of a number of stiff, horny plates or rings. These rings slightly overlap one another, forming a complete suit of jointed armor that covers the little creature from head to foot. Beetles are

clothed with very strong armor plating, but butterflies, bees, and many other insects are clad in much lighter suits.

The body of an insect is always divided into two distinct parts—a fore body and a hind body. Indeed, the word "insect," which comes from the Latin, means "cut into."

The two halves are joined by a waist. You can see this very clearly if you look at a wasp, which has such a delicate, threadlike waist that you may wonder why it does not break in two. Other insects, such as the tumblebug, have waists so thick as to be hardly noticeable, but the division is there all the same.

The six legs and the wings of an insect are attached to the fore part of its body—never to the hind body. There may be one or two pairs of wings, or, in some cases, none at all; but no insect ever has more than two pairs.

On its head an insect always has a pair of feelers, called antennae (än-těn'ē). They are most useful to the little creature; they act as

organs of touch and smell, and sometimes even of hearing. Some are long and threadlike, others are short, stout clubs; and some may even be fan-shaped or like beautiful feathery plumes.

On the insect's head, too, are a pair of very large eyes, called compound eyes. They are made up of a number of separate lenses, set side by side like the facets of a diamond, each one at a slightly different angle. So the owners of these wonderful eyes are able to keep a lookout in all directions without troubling to turn their heads. Between the great compound eyes most insects have three lenses, called simple eyes, or ocelli (ô-sĕl'i), but these are so small that you would seldom notice them.

Insects do not breathe through a nose as

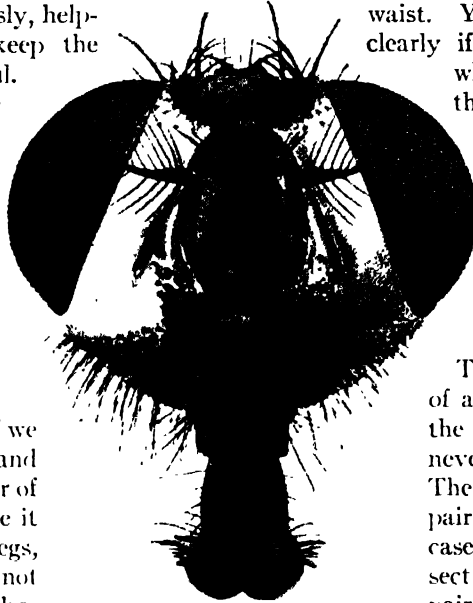


Photo by American Museum of Natural History

Here is a part of one of the most dangerous contrivances known to man—the common house fly. This front view of its head is from an enlarged model. Note the two neat pincushions that are its eyes.

## WONDERS OF THE INSECT WORLD



**A**—If your eye could magnify forty times, the egg of a monarch butterfly would look like this. The mother fixes it to a milkweed leaf, the baby's favorite food.

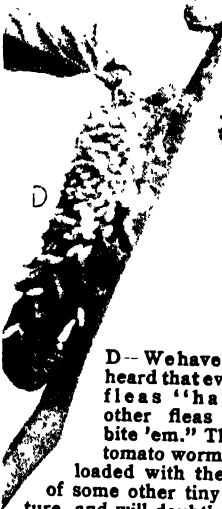
On this page are some of the strange little folk whose acquaintance you are going to make in later chapters of this story of the insects.



**B**—This neat ball of dung is both food and nursery for the strange scarab beetles who are rolling it along with their hind legs.



**C**—The pretty "oak apple" is the work of a gall fly, which lays an egg inside the tender leaf. When the caterpillar hatches and begins to eat, the leaf swells like a great blister.



**D**—We have all heard that even fleas "have other fleas to bite 'em." This tomato worm is loaded with the eggs of some other tiny creature, and will doubtless be eaten by the infants when they hatch.



**E**—This giant grasshopper (E) lives in South Africa. It is four or five inches long, and unlike most members of its family, it is fond of fresh meat. Here it is shown with a mouse it has caught for dinner.



**F**—The side view of a gadfly.

**H**—Some day these seven queer little affairs are going to turn into dragon flies, but at this stage the clumsy, bulgy-eyed creatures are known as dragon-fly nymphs.



**G**—Our honeybee has stuck her legs too far into the milkweed's insect trap.



we do, but through tiny openings, or breathing pores, placed at intervals all along their sides. These little openings are connected with a wonderful network of air tubes which carry supplies of oxygen throughout the insect's body. Spiral fibers like fine wires inside the tubes prevent them from collapsing under pressure, while tiny valves regulate the supply of air passing through the breathing pores.

So you see insects are not at all like the little four-footed beasts of the earth in the way they are formed or in the way they breathe—or even like the birds, although they often have wings and are able to fly. But all this we shall see for ourselves if we set forth on an exploring expedition into the insect world to study the habits and customs of some of the interesting little creatures who dwell there.

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# WONDERS of the INSECT WORLD

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## Reading Unit No. 2

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### LIKE FLOWERS ON THE WING

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How butterflies spend the winter, 3-276  
The eggs of butterflies, 3-277  
What caterpillars live for, 3-277-80  
How a chrysalis is formed, 3-280

The birth of a butterfly, 3-280-81  
When monarch butterflies migrate, 3-282  
How butterflies fool their enemies, 3-283-84

#### *Things to Think About*

What gives a butterfly its colors?  
How does the India leaf butterfly escape being eaten?

Why do birds leave the viceroy butterfly alone?

#### *Picture Hunt*

Do you think it is impossible to duplicate the colors of butterflies? Color plate 3-278  
Where can you find the eggs of the "painted lady"? 3-277

What is the life history of the monarch butterfly? 3-278-279  
What damage is done by the caterpillar of the cabbage butterfly? 3-282

#### *Related Material*

How can you distinguish between a moth and a butterfly? 3-287

How does an insect use its tongue or "proboscis"? 3-291

#### *Leisure-time Activities*

PROJECT NO. 1: Catch a butterfly with a net. Put it in a jar containing a wad of cotton on which are a few drops of carbonyl or carbon tetrachloride. Close the jar tightly. After the butterfly is dead, stretch out its coiled tongue or proboscis as far as it will go. Then scrape some wing scales on to a glass slide and ex-

amine them through your microscope, 3-280-81

PROJECT NO. 2: Look for smooth, yellow and black caterpillars on a milkweed plant. Put them in an empty milk bottle with milkweed leaves. Watch for developments in two weeks or less, 3-278

#### *Summary Statement*

Butterflies lay their eggs on plants and then fly away forever. The eggs hatch into caterpillars which eat and eat. As they grow,

they shed their old tight skins. Finally, a chrysalis is formed. The butterfly develops inside it and finally emerges.



The monarch butterfly is a monarch indeed. His handsome red-brown wings, with their black veins and white spots, have carried him far and wide over the earth. Here he is shown on a mallow blossom in a garden on Long Island. But other members of his clan brighten the fields of Europe and Australia. You will see his strange life history pictured on a later page.

tograph

Way Trade

## LIKE FLOWERS *on the* WING

### *How a Greedy Worm Can Turn into the Most Gorgeous Creature That Flies in the Air*

**W**HEREVER flowers are growing, we shall surely find butterflies—the real fairies of the sunshine.

In the gardens, in the meadows, they flit lightly and joyously from blossom to blossom, fanning their dainty wings in the sunshine, sipping sweet nectar, and reveling in the warmth and brilliance of the summer days.

Early in the springtime the first butterflies of the year come forth from the sheltered nooks where they have been hiding all through the cold winter months. The first bright day tempts them to try their wings and warm themselves in the sun's rays. They are rather stiff and feeble, poor things, and their beautiful wings look dull and shabby. But that is not surprising, for ever since last autumn they have been tucked away in some dark corner of a dusty shed or in some hole or crack where they could creep for shelter from the frost and

snow and wintry winds. There they have waited patiently for spring to come again.

As the days grow longer and the sun grows stronger, many new butterflies make their appearance in the fresh green world—white butterflies, yellow butterflies, blue butterflies, and butterflies of many colors, all with wings as bright and fresh as the newly opened petals of the summer flowers.

Of course we do not see butterflies of all kinds flying about in the same spot. Some of them love the flowery meadows, others the open woodland glades. Some flutter up and down the hillside, others haunt the low marshlands. They also have their favorite plants and trees. Wherever there are plenty of nettles and thistles, we are sure to find some of the "tortoise shells," "peacocks," "painted beauties," and "thistle" butterflies. The splendid ruddy-brown "monarch," king of American butterflies, likes to hover around milkweed; "white

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admirals" love honeysuckle; and where the wild cherries grow, we may often see the "tiger swallowtail" with its handsome black and yellow wings.

### Searching for an Orphan Home

But by no means all the butterflies can go flaunting about in the sunshine in a free and careless way. Many of the lady butterflies are intent on most important business as they move about among the plants. Watch a "painted lady" as she flutters round a large clump of nettles. Every now and then she settles on a leaf, pauses for a moment or two, and appears to be examining it very carefully; then off she goes to another cat.

If we look at the nettle we shall see that wherever the butterfly rested there are a number of pale green dots on the leaves. They are so small that we could cover four or five of them with a pinhead. But if we look at them through a magnifying glass—a delightful thing to carry with us when we are in the country—we shall see that they are the prettiest little things imaginable.

### Fairylike Eggs on a Nettle

As you have probably guessed, they are the eggs of my lady butterfly. When she has visited several nettle clumps and scattered a hundred eggs or so over the prickly leaves, she troubles herself no more about them, but flies off to enjoy the rest of her short life in the sunshine.

Although they are so tiny, the eggs are not all alike in shape and color. Some are like round, flat buttons with raised and ornamented edges; others might be fairy rolling-pins of carved ivory, or wee cups, caskets, or baskets, all beautifully fluted and sculptured. They may be white, yellow, or pale green, brown or almost black, while a

few are splashed with different colors very much as birds' eggs often are.

Most butterflies just pop an egg here or there in no regular order upon the plants they fancy; others take more pains to arrange the eggs in little clusters or neat rows or rings. But the eggs are always carefully fixed in place with a kind of glue, so that they cannot fall off the plants or blow away in the wind.

The tiny green eggs left by the female butterfly upon the nettle patch do not take long to hatch in the warm sunny weather. In about five days' time the little cases burst open and out come the babies of the "painted lady." But dear me! How strange that so dainty a butterfly should have such queer-looking chil-

dren. They are ugly, grayish little creatures with shiny black heads, and their wee, wriggling bodies are covered with short stiff bristles. In other words, they are baby caterpillars and not butterflies at all; and they are such tiny specks of things that at first you can hardly see them.

Caterpillars are dreadfully hungry creatures. Almost as soon as they are hatched, the baby insects begin to feed. Many of them start by eating up their own egg cases. Then without any waste of time they set to work gnawing the nettle leaves with their strong little jaws.

### He Grows His New Suit of Clothes

They eat so heartily and grow so fast that before very long the greedy young things begin to feel quite uncomfortable. Their skin gets too tight and is all stretched and wrinkled. Presently it splits down the back, and after a good deal of wriggling and struggling the little caterpillar walks right out of its skin and appears in a nice new suit

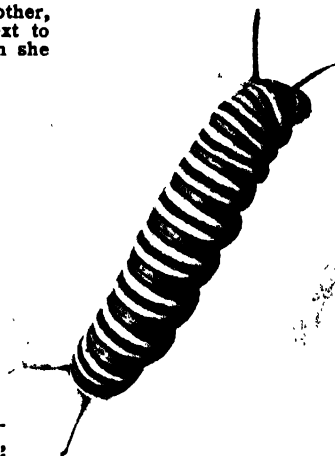


Photo by Cornelia Clarke

This is the painted lady, a butterfly who chooses a nettle leaf as a nursery for her children, and leaves them to grow there without any bringing up at all.

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Here is the strange story of the birth of a butterfly. Just below at the left is the mother, the tawny-red monarch butterfly. Next to her is her egg, greatly enlarged, which she has laid on a milkweed leaf.



After seventeen hours of hanging, our caterpillar begins to wriggle inside his skin. His head and neck swell, and finally his skin splits open, as shown below. Underneath is a beautiful green chrysalis.

When he has eaten his fill the caterpillar hangs himself up by the tail, as shown below, using a kind of sticky glue which he makes himself.

The fine yellow and black and white caterpillar above is what steps out of the egg to feed on the milkweed leaf.



Out of the shapeless chrysalis comes this beautiful creature at the right. He is a black-veined, white-spotted monarch, just like his mother. As soon as his wings are dry he will sail away in the light.



Above is the light-green chrysalis of the monarch butterfly, just as it was left hanging to the midrib of the milkweed leaf when the creature shed its caterpillar's skin.

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*We should not be surprised to meet any of these gay creatures of a summer afternoon, for though they look startling enough on the printed page, their costumes seem quite fitting along the roadside or in the garden.*

*In fact, we may be sure that in some way or other their bright clothes help to prolong their lives. In the center at the top is the well-known painted lady, or thistle butterfly, whose family name is Vanessa.*

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## WONDERS OF THE INSECT WORLD

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*The insect in the center above is called an owl butterfly. Turn the page upside down and you will see why. Some day when you are looking for something to do, take paper and pencil and draw the outline of*

*a moth or butterfly. Then, with your choicest paints, color it as exquisitely as you can. When you have finished, compare your handiwork with Nature's as shown on these pages -and try again!*



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## WONDERS OF THE INSECT WORLD

which has been gradually forming underneath the old one.

At first the new skin is very soft and tender, but it soon hardens in the warm air. Then, after a short rest, the caterpillars begin feeding again and munch away at the nettles harder than ever. They shed their skins five times in this way, and after each moult they are a little bit larger and darker in color.

not much good to see with. But since the caterpillar does nothing but eat all day long, its poor sight really does not matter much.

Behind its head the caterpillar has three pairs of legs, one pair on each of the last three body rings. They are short and stumpy, and end in stiff curved spines, with which the insect holds tightly to the leaf it is feeding on. These are called "true legs."

Farther along its body it has four pairs of



Photo by Cornelia Clarke

When you meet a big butterfly like this one, all dressed in black and yellow, you will know that you have a tiger swallowtail. He takes his name from

his swallow-tailed coat. Sometimes his wife is dull brown instead of being yellow. But no matter what her color they make a handsome pair.

When they are about two weeks old, the young caterpillars are big enough to be plainly seen as they swarm all over the nettles. We can hardly call them handsome. They are black and bristly, with a few yellowish markings down the sides of their long bodies; and all are so exactly alike that you could never tell one from another.

### Six Eyes and Sixteen Legs

Each caterpillar has a hard round head with a pair of strong jaws that cut the nettle leaves as cleanly as a pair of sharp scissors. In front are a tiny pair of feelers, called antennae (än-těn'ē), and six simple eyes, three on each side. These eyes are called ocelli (ô-səl'i). They are nothing but small transparent spots that reflect the light, and are

queer thick, soft legs that are called "false legs" or "cushion feet"; and right at the tail end is yet another pair which are usually called "claspers." So altogether our black bristly friend has no less than sixteen legs of different sorts!

In four weeks the painted-lady caterpillars are full grown. Then, suddenly, they lose their appetites. There are still plenty of nice young nettle leaves all about, but the overfed insects can eat no more.

### When Caterpillars Turn Restless

They grow restless, too, and begin wandering all over the plants. Every now and then one of the fidgety things will stand still, raise its head, and turn it from side to side as if looking for something. And that is exactly what the insect is doing. It does not

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feel at all well, and is seeking a comfortable spot where it may rest undisturbed for a while.

### **Cradles for Young Butterflies**

Presently it creeps under a leaf and proceeds slowly to spin a little pad or cushion of silk, fixing it firmly to the leafstalk. Then, when the work is finished, the caterpillar turns itself about, grasps its silk cushion with its claspers, and hangs upside down from the leafstalk.

In this curious position it remains for a few hours. Then it begins to shrink and draw upward, growing shorter and stouter. Dear me! What is happening now? Ah! the caterpillar is going to moult again. Now it begins to wriggle and squirm, holding fast to its pad all the while, till suddenly its skin splits down the back once more. After much kicking and struggling it manages to free itself, and the old crumpled skin falls to the ground.

But where is the caterpillar? It has disappeared. In its place hangs a pretty little shell-like thing, pale green in color and touched here and there with splashes of gold, silver, and copper. It is a chrysalis (*kris'â-lîs*). In this charming little cradle the caterpillar is quietly resting, like an enchanted princess, while it is slowly changing from an ugly grub to a lovely butterfly.

For nearly two weeks, while this wonderful transformation is taking place, the chrysalis hangs from the leafstalk, gently rocked by the breezes. Then the little case begins to darken, and through the half-transparent walls the colors in the wings of the new butterfly can be plainly seen.

### **Enter the Painted Lady**

This is a most exciting time. At any moment now the painted lady may break through its prison walls and come forth into the light and air, but you can never tell exactly when the wonderful thing will happen. Some butterflies are impatient to be free and lose no time in making their escape; others do not appear until several hours after the colors of their wings are visible.

Sooner or later, however, if we watch patiently, we shall see the chrysalis suddenly

begin to quiver. Then with a quick little jerk it bursts open, and the next moment the prisoner is free!

Slowly the new butterfly drags itself a little way up the nettle stem, leaving the chrysalis case empty and broken behind it. But is this the pretty winged insect we have watched and waited for? It does not look much like a "sunshine fairy." Limp and quivering it clings feebly to the stem, its wings all wet and crumpled and rolled up in little bundles on its back.

### **Magic before Our Very Eyes**

But wait! As we watch, the poor crippled-looking thing changes before our eyes. The crumpled wings unfold, showing their soft, pretty colors. Gradually, as the sun shines on them, all the wrinkles are smoothed out and the wings are spread before us in all their fresh loveliness. The butterfly rests perfectly still for a while to allow its wings to grow quite firm and dry. Then it opens and shuts them two or three times, fluttering them gently as if to test their power. At last, growing bolder, our painted lady suddenly rises into the air and is off on its first joyous flight in the sunlight.

It hardly seems possible that such a dainty butterfly can really be the very same insect that only a few short weeks ago was greedily munching the nettle leaves.

### **The Sunshine Fairy Flits Away**

Gone is its black, bristly skin; its body is now lightly clothed with soft, downy hair, and four big, glorious wings spring from its shoulders. Gone are the stumpy little forelegs and the clumsy hind feet; our butterfly has now six long, slender legs.

A pair of long, delicate feelers—the antennae—wave gracefully on the top of its head, and two big round eyes have replaced the six little eyespots. For now that it flies about, the insect needs to see where it is going.

The strong biting jaws have gone too. In their place the butterfly has a long sucking tube, or proboscis (*prô-bôs'is*), as it is called. No longer will the insect feed on nettle leaves. For the rest of its life it will live like a real fairy—sipping nectar from



the flowers and drinking glittering dewdrops from the leaves. We do not often see the proboscis, for when the butterfly is not taking a little light refreshment, the long tube is coiled up like a watch spring, out of the way.

The butterfly is now a "perfect" insect. It has gone through all its magic changes and reached the most wonderful time of its life.

## A Butterfly's Life Cycle

First, it was a crawling caterpillar. This was the time of growth, when its business in life was to eat as much as ever it could in order to store up strength to help it pass safely through its transformations.

Secondly, it was a chrysalis. This was its time of rest, when it lay quiet in its little cradle while the last and the most wonderful change of all was taking place.

Thirdly, it is now a lovely butterfly, a "perfect" insect, free to fly where it pleases, to visit the flowers and enjoy itself in the sunshine for the rest of its life.

A butterfly's wings are marvelous things. They are clothed on both sides with tiny scales, beautifully fitted together like the overlapping tiles on the roof of a house. It is these scales that give to the wings their beautiful colors and patterns. They are no bigger

No land that feels the touch of the sun is without its butterflies. Big and little, drab and gay, they brighten the short summer of the Arctic or flit all the year round through tropical jungles. Their fragile wings may carry them hundreds of miles at a stretch, and by taking an unbooked passage on any convenient ocean liner, certain species have migrated to every corner of the globe—for Nature always seems to be able to make provision for a butterfly.

than specks of fine dust, yet they are shaped in all sorts of different ways and each one has a wee stalk by which it is fastened to the wing.

Many of the scales—which are really transparent bags, very thin and flat—have a colored layer inside them; but the flashing, changing colors we see on some butterflies' wings are caused by the rays of light striking the edges of the scales at different angles.

They are very frail and delicate, these pretty wings, and very easily injured; yet they often carry the butterfly very long distances through the air. The American

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monarch travels for miles across country and even over the sea. In the autumn, when cold weather is approaching, large swarms of these hardy butterflies travel south from the eastern states to the Gulf states and the West Indies. On the way they rest in trees and bushes, like flocks of birds. Sometimes such numbers of monarch butterflies gather together in this way that the trees and shrubs are covered with them;

they hang in great masses from all the leaves and twigs and cling to one another in festoons.



Photos by  
Cornelia Clarke

So strong and quick on the wing is the bold American monarch that its tribe has now spread all over the world. It has invaded nearly all the Pacific islands, traveled to Australia and the west coast of Europe, and is found scattered far and wide in foreign lands.

Of course insect emigrants do not fly all the way from one continent to another. They journey partly by air and partly by boat. Thousands of tired butterflies settle on ships in mid-ocean and are carried to distant shores.

### Globe-trotting Butterflies

Monarch butterflies are not the only ones that travel in this way. Painted ladies and many white and yellow butterflies also cross the sea, taking advantage of favorable winds and resting on the ships they meet on the journey.

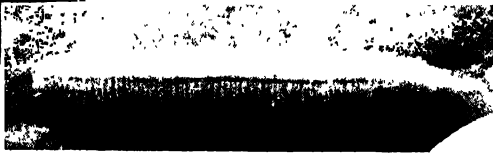
Wherever the sun shines, some of these dainty fairies are sure to be fluttering their delicate wings. High up on bleak, cold mountains they hover over patches of Alpine

flowers. Even on the borders of the great snow fields, where dwarf forget-me-nots and buttercups open their wee petals in the few short weeks of the Arctic summer, scores of the hardy little flutterers manage to live and find some plants on which their caterpillars can feed.

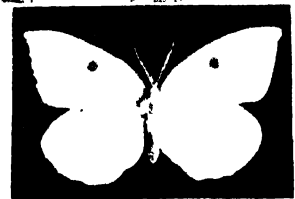
### Good Butterflies and Bad Ones

Thistle butterflies, tortoise shells, and peacock butterflies are welcome visitors to a garden. Their hungry black caterpillars like nothing so much as thistles and nettles and do not feed on flowers and vegetables.

The little blue butterflies and the coppers and hairstreaks are welcome, too, for their plump, rather sluglike children eat the troublesome plant



Here is the fellow that devotes his life to turning cabbage leaves into lace. Beginning at the left, we have him first, enlarged, in the egg; next, enlarged, in the larva, or caterpillar, stage, when he does his eating; third, in the pupa, or chrysalis, stage, enlarged; and last of all as the pretty white cabbage butterfly, so hated by farmers.



lice and the "woolly blight" that do so much

harm to garden plants and fruit trees. But the white and pale yellow butterflies are not so welcome, although they are very pretty with their satiny wings and black spots. Their green striped caterpillars are very troublesome, especially in the kitchen garden; they enjoy almost any green, juicy leaf and often strip the poor plants of all their foliage.

### Butterflies as Big as Birds

The worst offender of all is the cabbage white, which is not even a true American butterfly. It came from Europe ever so many years ago and settled on the land; and now it has spread itself all over North America and become a pest—which is not

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the way settlers in a new country should behave.

There are beautiful butterflies in all parts of the world, but the biggest and most gorgeous live in the hottest, sunniest lands. In the great tropical forests of South America giant butterflies with wings of dazzling blue sail slowly through the green glades or soar aloft and flutter round the tops of the high trees. Some of them are as big as birds; when their glorious wings flash in the sunlight, they can be seen as much as a quarter of a mile away.

### Winged Beauties of the Tropics

Others, almost as big, are a glittering green shot with silver; and some have soft, black, velvety wings splashed with crimson or banded with bright green, rose, and orange. In the forests, too, are great owl butterflies with big spots like eyes on their wings, which frighten small birds as the butterflies flit silently among the trees in the dusk.

There are also wonderful butterflies in the hot countries of the Old World. Such are the giant bird-winged butterflies in New Guinea, whose glorious blue-gray wings measure nine or ten inches from tip to tip. Others almost as big, trailing long golden tails on their hind wings or shining with

rainbow hues, haunt the steamy jungles of the East Indian islands. And mysterious-looking ghost butterflies with half transparent black and white wings fly through the dense forests.

### A Butterfly Magician

One of the most interesting of the Old World butterflies is the "India leaf butterfly" that lives in hot, dry forests where the leaves on the trees are scorched brown by the burning sun. Although not so big and gorgeous as many of the tropical butterflies, it is a fine, handsome insect. Its dark brown fore wings are crossed by a bright orange band, and the hind wings, of a deep blue shot with purple, bear a short, blunt tail.

As it flaunts about in the sunshine, boldly showing off its bright wings, no one could fail to notice this striking butterfly. But if you try to catch it, or if a bird swoops down upon it, it disappears in the most bewildering way. One moment it is there, plainly to be seen; and then, as if it had donned the cap of invisibility, it vanishes before our very eyes.

### Is It a Leaf or a Butterfly?

The butterfly has simply played a trick upon us. It has turned itself into a faded leaf—at least to all appearances. Directly it is alarmed, the wily insect pops down on a branch of the nearest bush or tree, closes its wings, and at once it looks in shape and color so like the dry leaves among which it has settled that you cannot tell the difference. Even the markings on the under

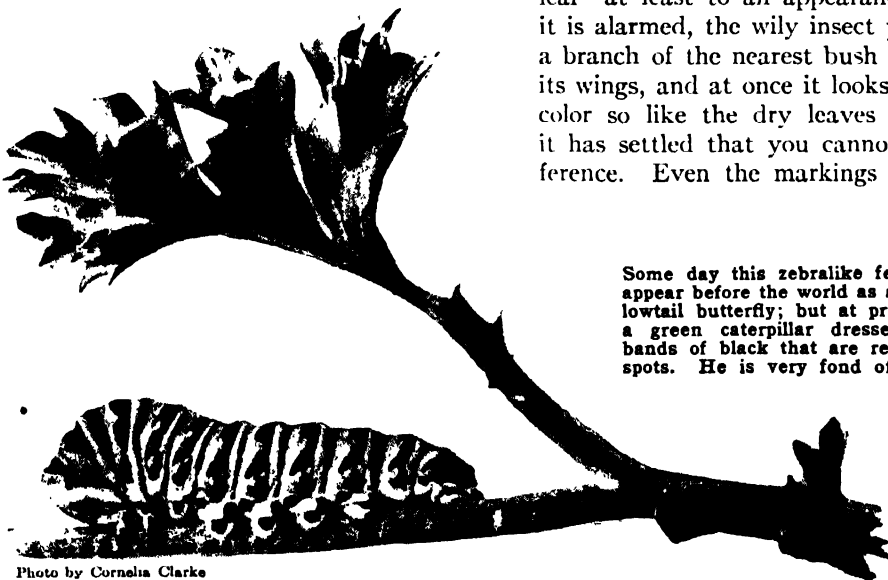


Photo by Cornelia Clarke

Some day this zebra-like fellow is going to appear before the world as an *Asterias swallowtail* butterfly; but at present he is only a green caterpillar dressed in handsome bands of black that are relieved by yellow spots. He is very fond of parsley leaves; and if you disturb him while he is at work on one, he will shoot out a pair of flexible, orange-colored horns, which emit a very disagreeable odor.

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side of the wings are just like the veining on the leaves; and the short, blunt tail is a perfect imitation of a leafstalk. So long as there is anything to fear, the leaf butterfly will keep perfectly still, with its head and antennae bent backward, quite hidden between its upright wings. There is nothing to give it away.

### A Trick That Fools the Enemy

This clever vanishing trick saves its life time and again—for hungry birds and other insect-eating creatures do not care for dry leaves. Butterflies, on the other hand, are delicate things, and they have no stings, no strong jaws, nor any other kind of weapon to defend themselves with. So they are obliged to seek safety by hiding from the sharp eyes of their enemies or by tricking them in some cunning way.

Perhaps you have noticed that when a butterfly settles on anything, it holds its wings close together in an upright position. On the under side the wings are by no means so brightly colored as upon the upper surface. So even if the insect does not turn itself into a leaf, it is much less conspicuous when it is resting than when it is flying about.

The monarch butterfly is protected in a different way. It has such an unpleasant flavor that birds do not like it at all. They soon learn to recognize the bold coloring of its wings and leave it severely alone.

There is another American butterfly, called the viceroy, that is really quite a nice, sweet-tasting morsel. But it is so like the bold monarch that birds are deceived by its appearance and very seldom interfere with it. So the viceroy escapes being eaten by mimicking the ruddy-brown coloring and black marking of its bitter-tasting cousin.

Still other butterflies rely for protection on the big eyespots upon their wings, which make them look enough like owls to frighten away small and timid birds.

### Chasing Painted Fairies

There are no prettier things to watch than the butterflies that we may find anywhere in summer days. So felt a great poet of nature as he remembered how he and his sister used to chase the butterflies when they were little children, and the summer days were so long. He describes it all in these lovely words.

"Oh! pleasant, pleasant were the days,  
The time, when, in our childish plays,  
My sister Emmeline and I  
Together chased the butterfly!  
A very hunter did I rush  
Upon the prey:—with leaps and springs  
I followed on from brake to bush;  
But she, God love her, feared to brush  
The dust from off its wings."



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## Reading Unit No. 3

### INSECT ACTORS

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How moths differ from butterflies, 3-287

Different kinds of moths, 3-288

The giant silk moth's life, 3-288-90

Hawk moths, 3-290

Moths that frighten other creatures, 3-292

How caterpillars are protected, 3-292-94

#### *Things to Think About*

How can you distinguish a moth from a butterfly?

How does the giant silk moth spend the winter?

How does the humming-bird hawk moth help flowers?

How do moths escape from enemies?

What habits of caterpillars save their lives?

Why is it important for us that most caterpillars should be eaten up?

#### *Picture Hunt*

How do moths hold their wings when at rest? 3-288

What moth keeps thousands of people at work? 3-289

What is inside a cocoon? 3-289

What helps a moth to take a drink of nectar from a flower? 3-291

How do some moths escape detection? 3-292

Are all moths drab in color? Color plate 3-294

How did the death's-head moth get its name? 3-293

What kind of feelers does a moth have? 3-294

#### *Leisure-time Activities*

PROJECT NO. 1: Look on trees in winter for large cocoons. Cut the case open with scissors and examine the pupa inside. Is it alive? Can you find the future wings and feelers? 3-289

PROJECT NO. 2: Look for

Cecropia caterpillars on cherry or other trees. They are large and green, and have colored horns. Put them in a large bottle and feed them with leaves. Study the way in which they build cocoons, 3-289-91

#### *Summary Statement*

Moths are related to butterflies but differ in having feathery feelers. They usually fly at night, and when at rest do not fold their

wings over the back. Moth caterpillars eat a good deal and usually spin cocoons or pupate in the soil or behind loose bark.

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If you will look closely at its back, you will see why the hawk moth below is called the death's-head moth.

It is interesting, when you see a bright or strangely marked caterpillar, to find out where he usually lives and so discover the reason for his coloring.

Our stylish friend at the right is one of the hawk-moth caterpillars. He is called a tomato worm.

Below is another hawk-moth caterpillar, enlarged. He looks ready for anything.

Here is the chrysalis the fellow above will make.

Photos by F. Martin Duncan and Cornelia Clarke



You have often seen the beautiful furry creature at the right, but you will hardly recognize him or even guess what he is for this head of a male moth is greatly enlarged. The handsome plumelike appendages are not ears but antennae, or feelers, which give to their owner a quick report of all sorts of odors and delicate air currents and other changing conditions.



Photo by Richard L. Cassell

### INSECT ACTORS

#### *Lightning-change Artists That Can Make Themselves Invisible before Our Very Eyes*

**M**OTHS are the plain cousins of the butterflies, for they mostly wear the sober clothes of dusk. There are a great many more of them, but we do not notice them so much. For although some of the moths are gaily colored and fly about showing their bright wings in the sunlight, most of them sleep in the daytime and do not come out until evening, when the butterflies have gone to bed.

Night-flying moths are soberly dressed, as a rule, in soft browns and grays; so when they are resting quite still on tree trunks or old wooden palings, or hiding in some dark corner, it is not at all easy to see them. Their dull coloring protects the weak insects from prying eyes.

We can hardly mistake a somber, night-flying moth for a gay sunshine-loving butterfly; but a moth that flies by day is often so gorgeously colored that it is not so easy to know which is which. We shall always be able to tell them apart, however, if we

look carefully at their antennae (ăn-těn'ě)—that is, the feelers on top of the insect's head.

A butterfly has long, slender antennae, like fine threads, that have tiny blunt knobs on the ends or are swollen at the tips rather like Indian clubs. A moth has antennae that are either like feathery plumes, fine combs, or simple threads, and they never have knobs at the tip.

A butterfly usually holds its closed wings upright over its back when it is at rest. A moth either keeps its wings spread out or folds them over its back like a cloak; it never holds them upright as a butterfly does.

A moth goes through just as many changes as a butterfly. But during its time of rest, the caterpillar of the moth does not turn into a chrysalis. It simply shuts itself up in a cocoon or buries itself in the ground; or it may creep into a crack in the bark of a tree or under a pile of dead leaves.

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There it lies like a tiny dried-up mummy till it is ready to awake as a perfect insect. Until then it is a pupa (pū'pā).

There are thousands of different kinds of moths, and they vary in shape and size much more than the butterflies. There are soft, fluffy "puss moths," all gray and white, with big heads and the prettiest of feathery antennae; "ermine moths" that appear to be wearing ermine cloaks when their white wings, dotted over with little black spots, are folded neatly over their backs; and gay yellow and red "underwings" that look as if they were dressed in dancing skirts when they flutter up and down the windowpanes on warm summer evenings.

Then there are moths that disguise themselves as faded leaves on little bits of bark, and others that mimic bees and wasps so perfectly as to deceive us completely as they hover over flowering shrubs. There are moths so small that you can only just see the wee things when they flutter their tiny wings; and giant moths as big as bats.

The largest moth of all is the great Atlas moth of India, whose wonderful wings are nearly a foot across. It is one of the silk moths, and cousin to the silkworm moths, whose caterpillars spin the threads from which our silk is made.

### The Useful Silk Moths

The silk moths are a large family of handsome creatures, many of them giants of the insect world. They all make wonderful silk cocoons. Only those woven by the caterpillar of the rather plain-looking silkworm

moth are of much value, although the silk spun by the huge caterpillars of the North American silk moth is sometimes used for making stockings.

This giant silk moth is a splendid fellow. Its broad body is clothed with reddish-brown hair banded with black and white.

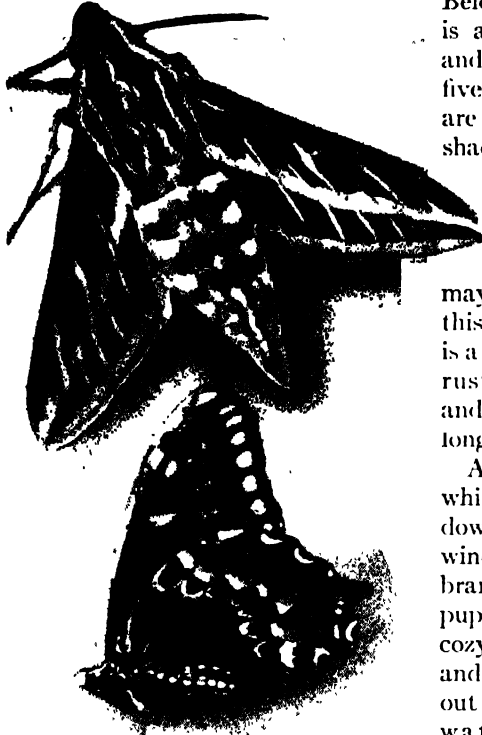
Below its big red head is a smart white collar, and its wings, which are five or six inches across, are a pale brownish color shaded with soft pink, buff, and orange.

In late autumn, on forest trees or in the orchard, we may find the cocoon of this giant silk moth. It is a big pod-shaped thing, rusty brown in color and about three inches long.

All through the winter, while the snow whirls down and the stormy winds shake the bare branches of the trees, the pupa lies sleeping in its cozy house. This is soft and fluffy inside to keep out the cold and has a waterproof covering against the rain and sleet. Not until the leaves are again on the trees does the pupa stir. Then one day, quite early in the summer, the tiny cocoon is shaken—not by the

wind but by the insect inside. Gradually it pushes its head through a small opening that has been left on purpose at one end of the cocoon, and forces its way out into the light and air. For an hour or two the giant moth clings to the tree, while its great wings expand and dry. Then, after a trial flutter or two, it launches itself from the bough and away it goes!

The caterpillar that makes this big cocoon is a startling-looking creature, nearly four



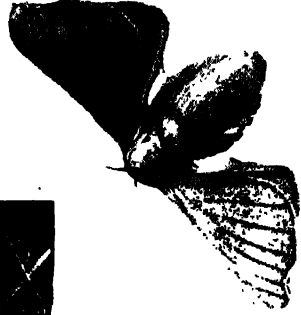
Photos by Cornelia Clarke

If you have read about the moths, you will probably know at a glance which of these is a moth and which a butterfly—for a moth never keeps its wings raised when it is resting. Here we have a striped sphinx moth, and, below, our friend the black swallow-tail butterfly.

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On the left is the silkworm spinning his cocoon—and silk for our dresses. When he has slept in it for a time, he will turn into the moth at the right.



Here are two of the charming people who live in the Land of Silk, where, over long centuries, they have known the gentle art of growing silkworms. Little girls there love to keep the little white moths as pets, and their own hands the mulberry leaves to feed the caterpillars.



The cocoon at the left is really three inches long, and belongs to the Cecropia moth, a great fellow sometimes measuring six inches across his outspread wings. He is sometimes called the American silkworm because of his silky cocoon.

This is the way the Cecropia moth looks when he is a fat pupa snug-gled away in his soft cocoon. Soon he will hatch into a moth and sail away.



At the left is a little white silkworm moth triumphantly bidding good-by to its silken home. If the silk fiber on that cocoon were unwound, it would be over 1,200 feet long.



Photos by Cornelia Clarke

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inches long. In color it is pale green with a yellow head and yellow legs, and its back is adorned with many little colored pimples of bright red, blue, and yellow.

The giant silk moths are very handsome, but if the moths held a beauty contest they would have to give the prize to the tailed moth of Madagascar, called by the natives the "king of the butterflies." Of course it is not a butterfly, but it is surely the most beautiful moth in the world, and it outshines the most brilliant butterflies of tropical countries. In shape it is very much like the swallow-tailed butterflies, but each hind wing has no less than seven tails. In color it is velvet black, splashed and banded with glowing gold, blue, and green. Its hind wings are especially gorgeous with shot crimson and purple hues and shining gold patches. It is a day-flying moth, and as it circles about the tree tops, its flashing colors are dazzling in the sunshine.

Though not quite so wonderful as this royal creature, there are many beautiful moths in the temperate countries. The hawk moths, with their long, narrow, pointed wings and torpedo-shaped bodies, are favorites with everyone. They are all noted for their swift, strong flight, and many have beautifully colored wings painted in soft, quiet tones.

There are over a hundred different hawk moths of various sizes and colors in North America. Their caterpillars, which are often a terrible nuisance, are known all over the country as tomato worms, tobacco worms, potato worms, and grapevine dressers.

One of the largest and most handsome of the hawk moths is the great pandorus

sphinx (pän-dō'rūs sfīngks), whose softly shaded green and buff wings measure fully five inches from tip to tip. In its caterpillar days it feeds on grapevines and Virginia creeper. Many others rival the pandorus, but the dainty humming-bird hawk moth is perhaps the most charming of them all. We know him well, for he loves to visit our gardens. Early in the evening he may be seen hovering over the petunia

bed or the honeysuckles, his quick wings vibrating so rapidly that they make a faint haze around his soft, furry body.

As he hovers like a humming bird above the flower, the moth thrusts his proboscis (prō-bōs'is), or sucking tube, which is very long, deep down into the nectar cup to reach the honey drops at the bottom. When he

withdraws his proboscis some of the pollen from the flower is almost sure to cling to it. This the moth carries to the next flower he visits and so helps to form the seeds.

But the most wonderful humming-bird hawk moths live in South America. Some of them are so exactly like the humming birds in size, shape, and coloring, and in the way they fly and hover over flowers, that it needs a very sharp eye to tell the difference between the insects and the lovely little birds they imitate.

### A Moth That Robs the Bees

Everyone admires the humming-bird hawk moth, but the death's-head hawk moth is not so popular. It is one of the largest of the hawk-moth family. It dresses in somber purple, brown, black, and yellow, and on its back between the eyes is a curious mark like a skull. Ignorant people are afraid of this moth because they think it brings bad luck. This of course is nonsense; but



Photo by F. Martin Duncan

Here is the giant silk moth, a beautiful fellow of red and brown and buff and orange. He is a cousin to the silkworm.

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It's clear why  
this should be  
called a bee  
hawk moth.

The bristly thing below  
is only a caterpillar.  
He will turn into a tiger  
moth some day, but  
now he is known to his  
friends as a "woolly  
bear."

Below is one of the  
hawk moths using his  
very long tongue to sip  
the honey from phlox.  
Hawk moths are known  
whose tongues are ten  
or twelve inches long.

The monster that lurks at the bottom of the  
page is only the caterpillar of the big Cecropia  
moth. Here it is enlarged, that you may see  
all its horns and wrinkles and bulges. You  
must imagine it a beautiful green, covered  
with red and blue knobs.

Darwin, the great sci-  
entist, once found in  
the Tropics a flower  
with a very deep bell.  
At once he predicted  
the finding of a moth  
with a very long tongue.  
And before long the  
moth was found, with a  
tongue the exact length  
he had foretold!

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the death's-head is not a well-behaved insect. It will sometimes creep into beehives and steal the honey the bees have stored up so carefully. If caught at its tricks, the robber gives a shrill squeak of a most uncanny kind. This it does by forcing air through its long proboscis.

### How the Sphinx Moth Got Its Name

Hawk moths are sometimes called "sphinx moths"—a name given to them long ago by an old naturalist because of a curious habit that all their caterpillars have. If you disturb one of the caterpillars when it is feeding, it will at once rear up its head and the front part of its body—seemingly to frighten you away. In this strange, stiff attitude it will often remain for hours at a time—as if, like the sphinx of the old Greek legend, it were engaged in profound thought.

Most hawk moths fly rather late in the evening, but humming-bird moths and bee hawk moths are out and about in the daytime. The bee hawk moth is wonderfully like a big bumblebee. It has a plump, furry body, and clear, transparent wings with only a border of dark scales around the edges. When, in the early summer, the moth hovers about the sweet-scented flowering shrubs in company with a troop of excited bees, you must have sharp eyes to distinguish it from the insects buzzing around it. Its deceptive appearance is certainly very useful to it. Hungry birds will pass it by; for although they enjoy a plump, soft-bodied moth, few of them care to tackle a quick-tempered bee with a sharp sting.

When the bee hawk comes out of its pupa case, its wings are covered with scales, just as are an ordinary moth's wings. But the scales are so loosely attached that

they fall off in the first flight, leaving all but the borders of the wings bare.

There are a number of moths belonging to another family, called the "clearwings," that have no scales, or only a few, on their wings. Like the bee hawks, these bright, quick-flying little moths are easily mistaken for other kinds of insects. Some have black and yellow bodies like wasps and hornets; others mimic bees or gauzy-winged flies and the bold little things fly about quite openly in the sunlight, for they are seldom molested by insect-eating birds.

So you see that in the insect world "things are not always what they seem." Even some of the biggest and brightest of moths—which could not possibly pretend to be dead leaves or stinging insects—manage to deceive their

enemies by "making believe" they are dangerous creatures ready to pounce. The big "eyespot" on the wings of the pretty Canadian peacock moth make it look so much like an owl, when it rests half hidden in the foliage of the trees, that it frightens away the small birds that come near it. The North American emperor moth is even more terrifying to timid woodland creatures; for as it crawls over the trees and bushes, slowly moving its strangely-marked wings up and down, it looks for all the world like the head of some poisonous snake about to strike!

### Caterpillars Are Never Safe

It is even more important for slow-going caterpillars to have some means of protection against the dangers all around them. Butterflies and moths can sometimes escape from their enemies by flying away. But caterpillars cannot. With their funny short legs they cannot even run. Once they are discovered by an enemy, they

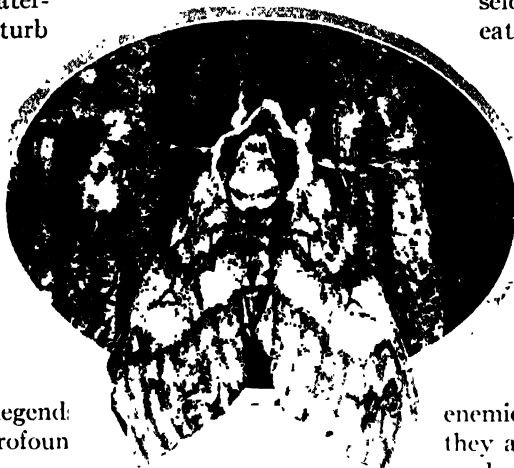


Photo by Cornelia Clarke

You would have to look twice to find this moth on the tree trunk.

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are done for. Yet these weak, defenseless creatures often outwit their enemies and grow up into sunshine fairies in spite of the way they are hunted in their young days.

### How Nature Protects Her Children

The great majority of caterpillars are soft, plump, tempting creatures, greatly relished by the hungry birds. So to save their tender skins the timid crawlers strive, as far as may be, to live hidden from prying eyes. They stay under the leaves or press closely against the stems of their food plants; and since they are nearly always green enough to match the leaves, or gray or brown enough for the stems and twigs, it is very difficult to see them—so long as they keep still. The very spots and stripes with which many of them are marked only make the concealment more perfect, for they always resemble the ribs or veining of the leaves, the colors of the flowers, or the patches of light and shade that fall upon the plants.

### A Game of Hide-and-Seek

The inchworms, or loopers, as they are often called, are especially clever at playing the game of hide-and-seek that is forever going on between the birds and caterpillars—a game in which the caterpillars always hide and the birds always seek. When they are not feeding—and even caterpillars are obliged to stop eating sometimes—the cunning creatures grip the stems or the slender branches of their own particular plant or tree and pretend to be twigs. And so exactly like twigs are they in shape and color, and in the way they hold themselves, that nine times out of ten you would not be able to say which were the real twigs and which were the sham ones. Even the buds and the leaf scars of the twigs are imitated by knobs and marks on the skin of the insect actors.

These queer caterpillars are called “loopers” on account of their peculiar way of curving themselves into loops when taking a walk. They loop along in this fashion because, instead of having four pairs of false feet, as most caterpillars have, they

have only one pair—right at the tail end of their long thin bodies, near the claspers.

The tiny mining caterpillars are so cautious that they never show themselves at all in the outside world until they are ready to spin their wee cocoons. They spend their early days hidden in little green galleries which they tunnel out between the upper and lower surfaces of the leaves, or burrow into the wood of trees and often do a good deal of damage. In fact there is no end to their troublesome ways.

### A Caterpillar That Lives in a Bag

Then there are bagworms—the funny little caterpillars of the *Psyche* (sí'kě) moths. They have hard heads but very soft, tender bodies. So the wise insects make neat little bags, and live inside them with only their heads and their tiny forelegs sticking out of the opening at the top.

The bags are made of fine grass blades, small twigs, pine needles, or scraps snipped from leaves, all carefully fastened together with silken threads. It is a funny sight to see the odd little creatures rocking along, trailing their queer homemade bags behind them.

Woolly bears and other bristly caterpillars do not trouble to hide themselves. They are safe from the attacks of birds, who will not touch the hairy, prickly things. We may often see woolly bears very busy among the vegetables and fruit bushes munching away at the juicy leaves in the most impudent fashion. They hurry along the garden path as if they had not a minute to lose. Woolly bears are always in a hurry; but if you touch them, they roll themselves up at once into prickly balls like tiny hedgehogs.

### Insect “Bluffers”

Big, gaudy caterpillars, when they are not protected by bristly hairs, usually have a most unpleasant flavor. The birds seldom interfere with them. Some of the caterpillars that would taste better try to frighten away their foes by pretending to be fierce, dangerous creatures. The large green caterpillar of the sphinx moth looks alarming when it rears up as if it were about to attack

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you. At the end of its back it also has a large curved spine.

Stranger still is the behavior of the puss-moth caterpillar. It is an odd little creature, dressed in bright green and purple. Behind its head is a bright red ring adorned with

head of the caterpillar is pulled back into the red ring and serves as a big nose in the middle of the hobgoblin's face; the black spots become eyes; and the pink lashers are shot out from the forked tail which the caterpillar turns up over its back. The



Photo by Cornelia Clarke

This beautiful tan and brown creature is the gigantic Polyphemus moth. Spread out against the daisy are

two big black spots. Its back is humped, and at the end of its body are two absurd little tails.

### A Frightful Hobgoblin

We may find the puss caterpillar feeding on wild cherry trees. It looks so plump and harmless that any bird might be tempted to snap it up. But the moment danger approaches, it rears up, draws back its head, and puffs up as if it were swelling with rage. And there, instead of a defenseless caterpillar, is a wicked-looking little hobgoblin with a round red face and staring black eyes. Above his head he brandishes two dangerous-looking pink lashers. It is enough to scare the boldest bird!

You see how the trick is done? The real

its long, plumelike antennae, one of the signs by which you may know it for a moth instead of a butterfly.

creature spits, too—for it can spatter you with a fluid that makes your skin smart and tingle!

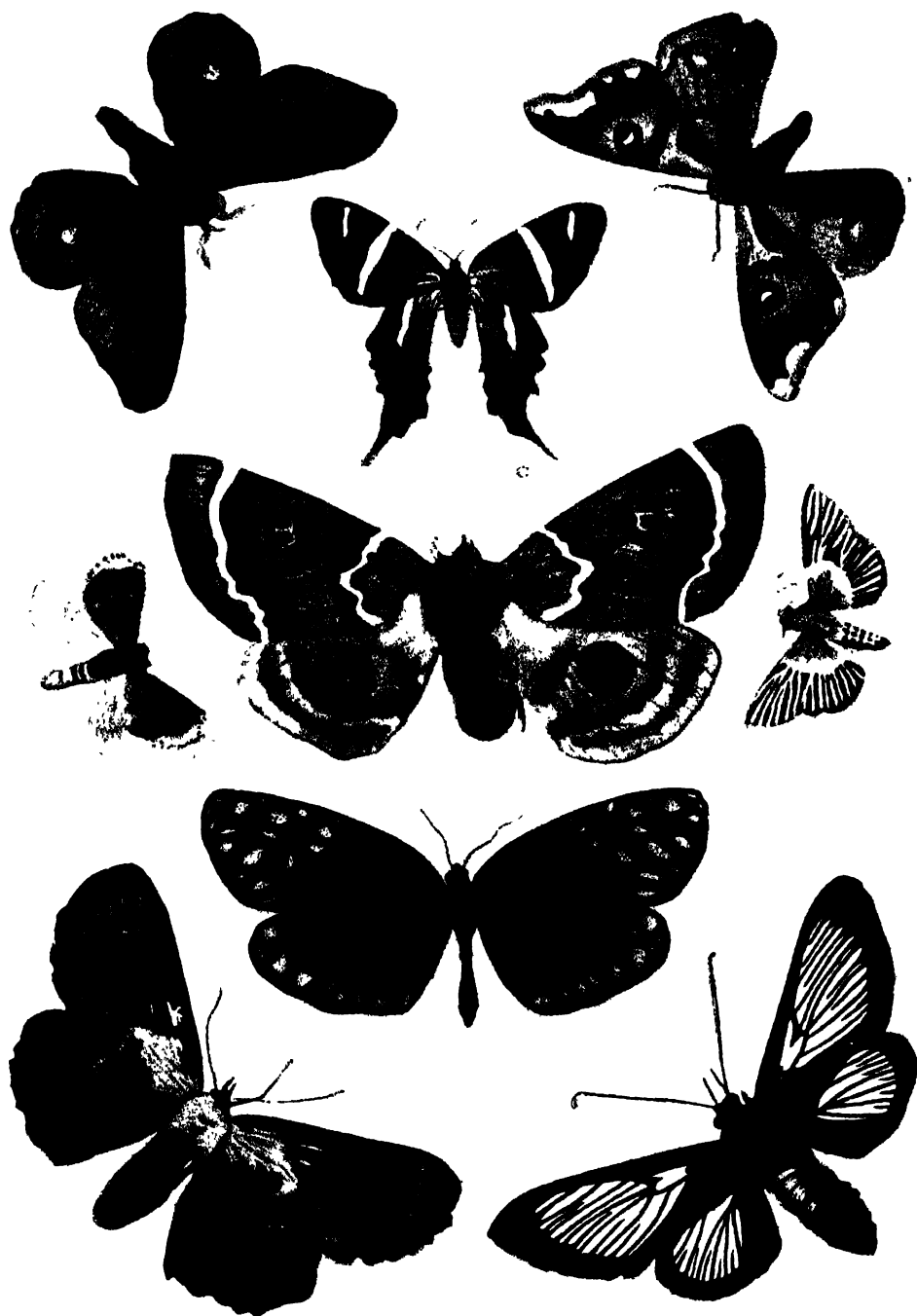
In spite of all their tricks and disguises, the caterpillars still get eaten up in vast numbers. And a good thing, too! If they were to have everything their own way, there would soon be very few green leaves left on the trees. Nearly all our vegetables would be devoured, and our food crops would be spoiled. Fortunately caterpillars are delicate things; cold wet weather kills large numbers of them, and the birds eat still more. In keeping down insect pests the birds are our best helpers. All through the spring and early summer they work away hunting for insects to feed all the baby birds at home in their nests.



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*Often the smaller moths and butterflies outdo their larger relatives in delicate beauty. Their markings are so fine that the naked eye can scarcely see them, and their colors are marvelously blended. Such dainty*

*little fellows are likely to be seen flitting about an open meadow or along the roadside. But most beautiful are moths hatched from caterpillars feeding on woodbine. At bottom center above is the monarch butterfly.*



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## Reading Unit No. 4

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### INSECTS WITH STINGS

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Where insects spend the winter, 3-297  
How the bumblebee builds its nest, 3-297-98  
How worker bees are born, 3-298-99

The work of bumblebees, 3-299  
The life of solitary bees, 3-300-4  
Social and solitary wasps, 3-304-7

#### *Things to Think About*

How does a bumblebee colony start?  
How do newly born carpenter bees escape from their cells?  
How do mason bees make their nests of cement?

What are the habits of insect "cuckoos"?  
How are the papery nests of yellow jackets made?  
How do some wasps make sure their young have enough to eat?

#### *Picture Hunt*

How do some wasps make use of their stingers? 3-298  
Where are bumblebee babies kept? 3-300  
What insect can bore tunnels in wood? 3-301

Who were the first paper makers? 3-304-5  
Where do yellow jackets live? 3-296

#### *Related Material*

What bad habits are found among cuckoo birds? 4-174-75

What animals besides wasps build tubes? 3-120-23

#### *Leisure-time Activities*

PROJECT NO. 1: To study the sting of a wasp, kill a wasp and pull the sting out. Place it on a slide under the microscope, 10-489

PROJECT NO. 2: To study the nest of a paper wasp, knock one down cautiously. When no wasps are near, remove the tops of the cells and examine their contents.

#### *Summary Statement*

Bees and wasps have four wings and a sting. Most of them have homes in the ground, in a

nest of paper or mud, or in tunnels in trees.

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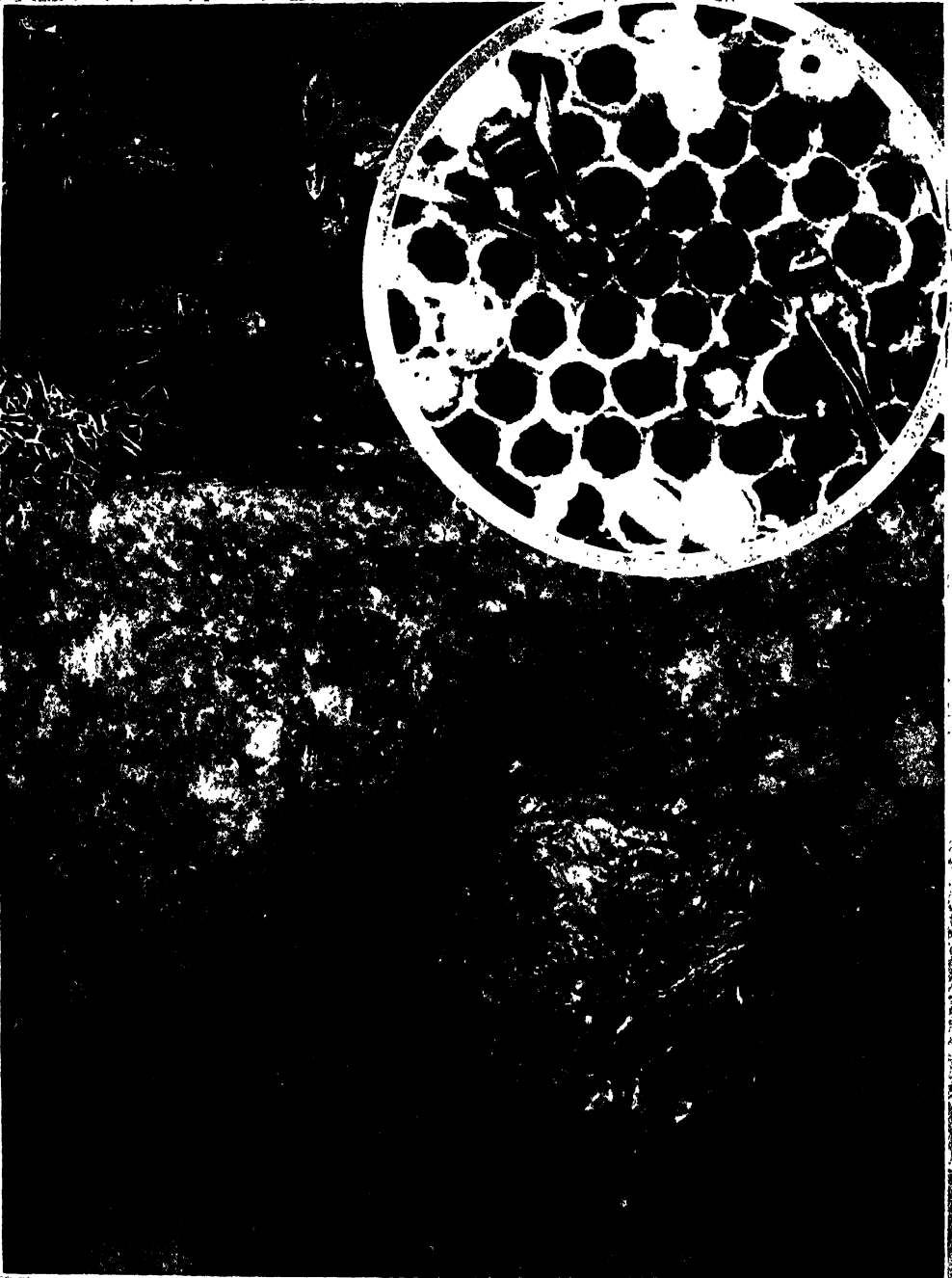


Photo by American Museum of Natural History

The wasp would seem to have taken a lesson in building from the bee. Of course it is a more blundering workman than its skillful cousin, but it uses the same plan for its apartment house of six-sided rooms—as

the picture up in the corner will show. There we have two of our touchy friends, the bald-faced hornets. Let us pass right on quietly! Down below is the safely-hidden, underground nest of some yellow jackets.

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If your eyes were microscopes a hornet's face would look like this to you. The creature has five eyes. The two large ones, beside the jointed antennae, are made up of many tiny level surfaces, which give the insect a picture that is much like a mosaic. The three small eyes on the top of the head are simple single lenses which are very sensitive to light. Below the eyes are the mandibles, with which the hornet cuts up its food.



Photo by Richard L. Cassell

### INSECTS *with* STINGS

#### *Carpenters, Masons, Miners, and Skilled Workers of All Sorts, the Bees and Wasps All Carry Concealed Weapons*

**W**HEN the winter comes, the insects vanish. Where have they gone? Are they all dead? When summer comes again, will there be no flies or bees in the land? Of course there will, as soon as the warm days arrive, there will be just as many as ever, flying and buzzing about.

Of course a great many of the insects die as soon as wintry weather sets in; but some of the hardier ones live through the winter, tucked away in sheltered corners or buried under heaps of rubbish where the frost and bitter wind cannot harm them. A great many spend the cold months of the year sleeping in their cocoons or chrysalis cases, and do not change into perfect insects until the first warm days of spring. And there are heaps of eggs, lying in all sorts of safe places, from which new armies of grubs and caterpillars will hatch out as soon as the fresh green leaves and young shoots appear upon the plants and trees.

So the first days of spring are exciting

days. All Nature's children begin to stir themselves and wake up after their long winter sleep.

From under a pile of dry moss, where she has been hiding all the winter, a big black and gold bumblebee crawls out into the sunshine. Her wings feel stiff and cramped, and she is weak and feeble, poor dear, for she has had nothing to eat since last autumn. But a little rest and a sun bath revive her. She soon cheers up and begins to make her toilet, carefully combing her soft silky hair with the claws on her hind legs and cleaning and smoothing her delicate wings. Before long she feels able to take a little exercise and sets off for a short flight.

#### **When a Bee Goes House Hunting**

At first the bee enjoys a little holiday. She just potters about, visiting the newly opened flowers, sipping the honey, and taking a good look round. She has a big task before her; so she wisely waits a little

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while until she has regained her strength and is fit to begin her work. But she wastes no time. In a day or two she is bustling about, poking her head into every little hole, pushing her way underneath tufts of grass, and examining the ground in every direction just as if she were looking for something. And so she is. She is house hunting—looking hard for a convenient hole where she may start a home. If she discovers a deserted mouse's hole or a roomy underground burrow that once belonged to a mole, she will probably take possession of it. But she is very fussy, and if she cannot find an empty house to suit her, she starts digging the foundations of one for herself—under a patch of moss or on a soft bank overgrown with wild plants, where she is well hidden while she is at work.

When her house is ready, she proceeds to furnish it. Backward and forward she flies, fetching little bundles of moss, fragments of grass, and fine rootlets. These she dumps on the floor, pulling and tearing the stuff with her strong jaws and sturdy legs to make it soft and comfortable.

### Furnishing the Nursery

When she has about filled the house with this material, she hollows out a snug little chamber in the middle of the mass. Then off she goes again to collect honey and pollen, which she brings home and works up into a thick, sweet paste.

On the top of the honey she now deposits a few eggs. Then she builds a circular wall of soft beeswax around them, and shuts them in with a neat little lid.

By this time our bee must be getting rather tired—but her labors are by no means ended yet. She makes two or three more honey cakes, pops a cluster of eggs on each, and shuts them up in a waxen cell.

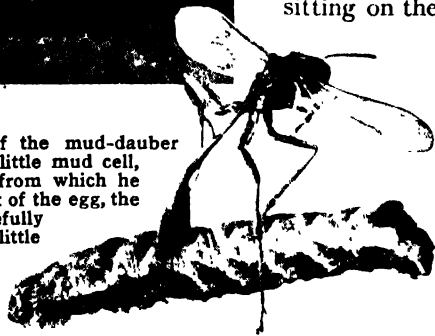
### Honey for a Rainy Day

Her next care is to gather and store provision for rainy days, or for days when she has so much to do that she cannot possibly leave home. She makes one or two good-sized wax tubs and fills them up with honey; then she takes a little rest, sitting on the top of



Photos by Cornelia Clarke

Above is the promising child of the mud-dauber wasp. He is shown in his snug little mud cell, where his mother laid the egg from which he hatched. But when he came out of the egg, the cell had no opening at all. Carefully locked up out of harm's way, the little "worm" began to eat of a juicy spider that his thoughtful parent had provided, after rendering the creature unconscious by a skillful stab of her sting. In a state of coma the spider lived on in the cell, and all fall and winter and spring the greedy larva ate and ate upon it, and grew and grew until he was old enough to turn into a full-fledged wasp. Then he bored his way through his mud prison and came out into the world.



This digger wasp knows at just what spot to insert her fatal sting in order to paralyze but not to kill the caterpillar. As soon as it ceases to wriggle she will drag it down into her nest, where it will furnish fresh meat for her baby to feed on.

the cells like a brooding hen, so that the warmth from her small body may help to hatch the eggs.

The eggs in the cells soon hatch, and the baby bees find themselves in a nice little nursery. And oh, joy! the floor is actually made of sweet, delicious food. The lucky little things have nothing to do but eat and sleep and eat again.

They are queer little creatures, these bee babies—not a bit like mother. They are tiny white legless grubs, unable to do anything but suck up the food their thoughtful mother has made ready for them. She knows when her babies are hatched; and to make sure they have enough to eat, she goes around from time to time and pours a kind of infants' food made of honey and pollen through a small hole in the roof of the nursery.

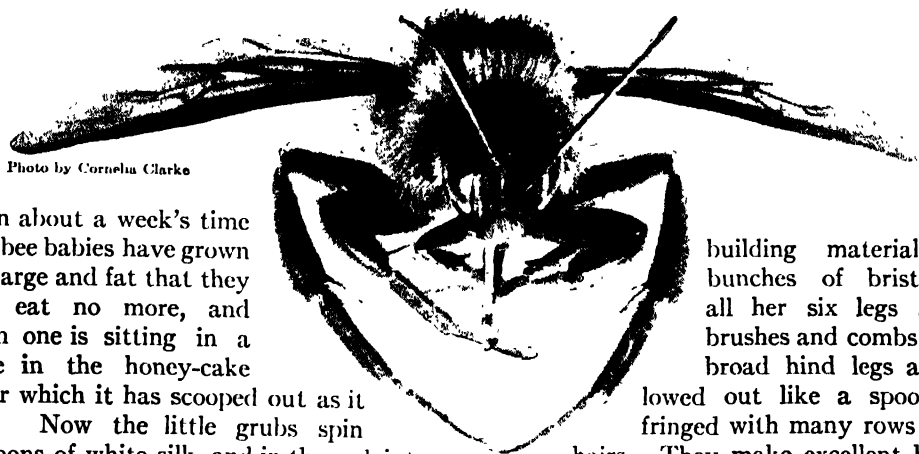


Photo by Cornelia Clarke

In about a week's time the bee babies have grown so large and fat that they can eat no more, and each one is sitting in a hole in the honey-cake floor which it has scooped out as it fed. Now the little grubs spin cocoons of white silk, and in these dainty cradles they rest while they are being changed into grown-up bees.

The mother is most excited when at last she hears her children moving about in the old nursery. She hastens to scrape away the wax that shuts them in and welcomes her eldest daughter.

### **Velvety Suits of Black and Orange**

The new bees are very much like their queen mother, but they are smaller and are called "worker bees." Very trim and smart they look in their fresh, velvety suits of black and orange—after they have once brushed their coats and smoothed the crumples out of their gauzy wings.

The bees have four wings; and on each hind wing is a row of tiny hooks that fasten into a fold on the lower edges of the upper pair. So when a bee flies, the two wings are joined together. This gives the insect a much stronger, swifter flight. The bee needs strong wings to carry her long distances through the air, as she often has to travel for miles in search of honey and pollen.

### **The Bumblebee's Market Basket**

In every way the hard-working bumblebee is fitted for her busy life. She has a sucking tube to draw up the nectar from the flowers, and a honey bag in her throat to carry it home in. A strong pair of jaws helps her to bite and mould the wax and

If you had the eye of a microscope this is the way our friend the bumblebee would look as he comes buzzing toward you on a summer's day.

building material, and bunches of bristles on all her six legs act as brushes and combs. Her broad hind legs are hollowed out like a spoon and fringed with many rows of stiff hairs. They make excellent baskets

to carry home the pollen when the bee goes marketing. Besides all these tools she has a splendid pair of eyes to see with; a pair of sensitive feelers on the top of her head with which she touches and inspects everything that comes her way; and, to defend herself, a sharp sting like a bladed sword, with a poison bag at the base to make it more deadly.

The worker bumblebees at once set to work to help their mother. They go to fetch provisions; they help in building wax cells and honey tubs; and go round with the infants' food to feed the babies. The queen bee now reaps the reward of all her toil and care. Soon she is surrounded by so many willing workers that she is able to leave all the housework to them and content herself with laying eggs.

### **Who Are the Drones?**

So the bumblebee's family has grown larger and more prosperous as the bright summer days pass by. Then toward the end of the season, a few young queens, exactly like the mother, come from some of the cocoons; and small drones, which are male bees, also make their appearance in the nest. The drones do no work, but fly about with the young queen bees, enjoying the last few weeks of summer weather.

Soon the days grow short and the nights grow cold. The bees cease working and their cheery buzzing is no longer heard.

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The first winter frosts kill nearly all the busy workers. The old queen mother and the drones die too, and only a few young queens, who sleep through the winter in some sheltered nook, live until the spring comes round again.

The bumblebees and the honeybees, who

some insects, quite as large as bumblebees. They have very powerful jaws with sawlike edges, and with these they tunnel into great trees, old decaying stumps, and even into dry gateposts and fences.

It is the lady carpenter who does the hard work. The male carpenter bee is a



Photos by Cornelia Clarke

Here is a bumblebee's nest, with one of the bees shown in the oval. Some of the brown cells in the nest have been opened in order that you may see the little white grubs that are curled up inside. Some

day they too will be bumblebees. This family of bees, which had built their nest in a chipmunk's hole, was made up of ten grown bees, three youngsters just hatched, and those sausagelike babies.

live in hives and make delicious honey for us, are called "social bees," because large numbers of them live and work together in a friendly, social way. Bees that live alone are called "solitary."

### Some Bees Are Hermits

Solitary bees are quite as interesting in their ways as the bumblebees and the hiving bees. There are hundreds of different kinds to be found all over the world, and many of them make the most wonderful and beautiful nests. There are carpenter bees, mining bees, mason bees, leaf-cutting bees, and ever so many others.

The big black carpenter bees are hand-

lazy fellow who does nothing but enjoy himself. So the mother bee has to provide for her family without any help from her mate—which is the usual way in the insect world.

But the carpenter does not worry. She sets to work with a right good will and digs out a long, narrow tunnel, about a foot deep, in the wood. Then she divides her tunnel into a number of separate cells, with thin partitions made from the sawdust and chips of wood she has scraped out and mixed with a kind of glue from her own mouth. In each cell the bee places an egg and a nice big cake of honey and pollen before she carefully seals it up.



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These South American carpenter bees have hollowed out the trenches in the wood with their own jaws.

Photo by American Museum of Natural History

She makes several of these burrows, each one fitted with about a dozen cells, and then her work is done. She does not wait to see her children, but flies off for her holiday.

### Orphans Locked Up in a Tree

Before long the eggs hatch out and each little bee grub comes out of its shell—to find itself a lone prisoner shut up in a cell. But the bee grub doesn't mind. It sucks at its cake, and when it has eaten this all up, it spins a cocoon and quietly goes to sleep—to awake in a few short weeks as a splendid carpenter bee.

The bee in the lowest cell is the first one ready to come out—for the egg from which it hatched as a fat little grub was the first one laid by the mother. It gnaws its way through the floor of its cell and finds itself in a short passage leading to the outside world. At last it is free! One by one the bees in the upper cells now make their escape in the same way. They have only to break through a single thin partition and the way is open before them.

### A Neat Back Door

You will have to admit that it is clever of the bee to arrange all those handy little back doors for her children. If she did not do this, and if all the young bees were obliged to leave the burrow by the front entrance, probably none of them would succeed in getting out alive. For those in the lower compartments would have to bite their way through ever so many floors before they reached the top; and in their struggle

to get out, they would disturb and hurt all the other poor bees, who would not be ready to leave their cells.

The pretty little blue and green carpenter bees tunnel into twigs, brambles, or any long-stemmed plants that have a soft pith, easy to work in. Like the big black carpenter bee, the little mother divides her burrow into a number of separate cells by carefully fitting cross partitions, made from chips of pith, all the way up the hollow shaft.

### Good Manners among the Bees

There are no back doors to these little nests, but the little carpenter bees seem to be so well-behaved that they never attempt to push rudely past their younger brothers and sisters. The eldest bee, in the bottom cell, bites a hole in the ceiling and then rests patiently until the next bee is ready to do the same thing. And so they wait politely, one for another, until they are all ready to leave the nest. Then the youngest bee leads the way from the top-most cell, and the others follow in an orderly procession.

Outside the nest the little bees find their mother ready to welcome them. Instead of flying off as soon as she has sealed up the last cell, like the big carpenter bees, she waits and watches at the top of her nest until her children are grown up. The little family party fly around and enjoy themselves in the sunshine, but they do not spend all their time in idleness. Together the old bee and the young bees set to work to clean out the nest, removing all the broke

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partitions and making it neat and tidy. Later one of the young bees will take possession of it and fit it up for her own children; but how they decide which is to be the lucky one, nobody can say.

The stout fluffy little leaf-cutting bee that we often see bustling about the rose bushes has several interesting tricks. She is a good carpenter and a clever upholsterer, as well as a skilled maker of honey cakes. If she finds a ready-made burrow hollowed out by some other insect, she will take possession of it to save time and trouble; but if not, she will make one for herself.

She bores a long, straight tunnel in a piece of soft wood, rasping away with her jaws and kicking the chips behind her as she goes. Then she walks backward and pushes all the loose stuff out of the hole.

When her tunnel is finished she bustles away to the nearest rose bush and, using her jaws as a pair of scissors, snips a neat little bit out of one of

the green leaves and flies home with it. All through the hot sunny hours of the day this busy little bee works at top speed, cutting out rose leaves, carrying the tiny scraps home, and stuffing them into her tunnel.

When she has collected a little pile of rose-leaf cuttings, the bee stops at home for a bit. But she does not rest. She pulls and twists the tiny pieces about with her legs and her jaws until she has made the prettiest little rose-leaf cell imaginable, like a tiny thimble. All the pieces are beautifully fitted

together so that they overlap, and each one is firmly fastened down with glue from the bee's mouth.

The mother uses rather long, oval-shaped pieces of leaf, all the same size, to make her thimble; but when she has half filled it with

soft, pasty honey cake and laid an egg on top, she closes the cell with two or three round pieces which exactly fit the open end of the green thimble.

The bee fills her tunnel with the rose-leaf cells, packing them together one on top of another. She is seldom content with just one burrow, and often makes two or three before she ceases from her labors.

Some little leaf cutters choose the leaves of other plants instead of roses for their thimble cells; and one, the poppy bee, makes hers with little bits cut from the blooms of scarlet poppies.

### How the Bees Make Cement

Mason bees prefer more solid materials to build with. No flimsy rose leaves or poppy petals for them! They make their nests of clay and sand on a firm foundation of rock or stone; or, for even greater safety, they build them in holes in walls, old posts, under the eaves of houses, or inside hollow tree trunks.

Several cells are placed side by side like earthen pots or jars; the little mason builds them up, one by one, with tiny pellets of cement made by mixing sand or dry earth and her own natural glue. Using her jaws and her sturdy forelegs as building tools, she pounds and plasters the cement into shape, adding bits of rough gravel or small



Photo by Cornelia Clarke

The little leaf-cutting bee is not really so large as this, nor is her dainty little thimble of a nest—which she has been clever enough to make out of a leaf—so large as it is shown in the picture.

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Here is the handiwork of two different kinds of masons, and a picture of one of the masons at work. This mason bee seems to be giving her cell a final inspection. It should be strong and durable, for she has manufactured a special kind of cement out of which she made her house. It will stand wind and rain, and will serve her purpose perfectly.



Photo by Cornelia Clarke

stones here and there to strengthen the walls of the cell. She carefully smooths the inside of the little pot to make sure there are no rough edges to hurt the tender skin of the little bee grub for whom it is intended. When she has put an egg and a supply of food inside the cell, she closes it with a lid of plain cement—without any stones or gravel mixed with it; for the young bee must not be injured when it breaks its way out.

When six or more of these little cells are finished, the mason bee covers them all up with a rough layer of cement. The completed nest is as strong as a fortress and looks like nothing so much as a clod of dried mud.

That is how the true mason bees make their nests. Some of their relatives use the gummy resin that oozes from pine trees; others make burrows in the ground and line them with wool or cotton fiber stripped from the leaves of woolly plants; and one little mason actually uses empty snail shells as nurseries for her babies. There really seems to be no end of different ways in which these wonderful little solitary bees provide for their children.

There are hundreds of interesting miner bees—some no bigger than flies, others

nearly as large as honeybees. They make their burrows in the ground, often choosing a sandy bank for their mining operations. Although they are called “solitary bees,” the little miners are fond of company, and hundreds or thousands live together side by side in underground towns and villages. But each bee in the colony occupies its own home and lets its neighbors alone. Indeed, it is far too busy to waste time gossiping and playing.

### Landlords and Tenants

In some of the bee towns every miner has a home of her own, but in others they all live in apartment houses. Each house has a main entrance and a central corridor, which is tunneled out by several bees working together in friendly fashion and is the common property of them all. To right and left of the corridor are several passages leading to the private rooms of the bees living in the house. These are entered only by the rightful owners.

Miner bees really live in the burrows, and bring up their children by hand—so to speak—instead of walling them up as most solitary bees do. On a hot sunny day the bee towns hum with life as the busy

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little inhabitants bustle in and out fetching and carrying food for their young ones at home.

But if the clouds gather in the sky and a few raindrops fall, the cheerful humming ceases. All the little miners hurry indoors, and they will not show a wing above ground until the sun comes out again. To protect their underground towns from being flooded by sudden showers, the wise insects fix funny little crooked chimneys over the entrances to the tunnels. So the rain cannot get in and their houses are always warm and dry.

Among all these industrious insects there are a few who do not deserve to be called "busy" bees. They are lazy things who do no work at all; and more than that, they steal the food and the nests of their hard-working relatives. These are called "cuckoo bees," because, like that bold bird, they make no nests of their own, but expect others to provide for their children.

One of these cunning little insects may sometimes be seen loitering about outside the burrow of a leaf-cutting bee. She seems to be examining the flowers near by, or to be busy cleaning her fur coat and her wings. Really she is watching the leaf cutter. When the busy little mother is away from home, cutting out the last little pieces of rose leaves for one of her cells, the sly cuckoo bee slips into the tunnel and pops an egg beside the one already laid in the little green thimble by the rightful owner of the nest. When the leaf cutter comes back she is in such a hurry to get on with her work that she closes up the cell and never seems to notice the strange egg inside it.

Now there is not enough food for two in

the cell; and the greedy cuckoo grub, either because it hatches first or because it is stronger than its companion, eats nearly all of what there is. So the poor baby leaf cutter dies of starvation—and it is a cuckoo bee instead that finally comes out of the nest.

Other industrious bees are tricked in the same way by the curious "cuckoos." There is one big lazy bee that actually lives in a bumblebee's nest. There she lays her eggs and calmly helps herself to food from the honey tubs, without doing anything in return

for her board and lodging. She is so like a true bumblebee in appearance that the busy workers do not seem to notice the stranger among them. Anyhow, the cuckoo bee is not turned out of the nest as she deserves to be.

Wasps are not nearly such popular insects as bees. They look so fierce and carry such horrid little poisoned daggers that many people are terrified by the bold little warriors in their black and yellow jackets. Yet wasps are really very interesting and busy little folk. To be

sure, they are quick-tempered. But they are perfectly harmless if you let them alone. Wasps will not sting you if you do not frighten them or bother them when they are busy. Even hornets, though they look alarming, are peaceful enough if you don't annoy them.

### A City of Wasps

There are social wasps and solitary wasps—just as there are social and solitary bees. Social wasps make wonderful nests. Some of the nests are so large as to form wasp cities, where thousands of busy workers live together. All through the sunny hours of the summer days constant streams of ex-



Photo by Cornelia Clarke

These cunning paper wasps chose a gray house and then, under the eaves, built them a nest out of gray paper, which they made by chewing up bits of an old board. No one ever taught them what every newspaper man knows, that paper can be made out of wood pulp; but somehow they learned it, more thousands of years ago than we can count.

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This is the way a wasp looks—face to face.

The jaws and other parts of a wasp's mouth have amazing strength, for with them the little creature must gouge out and chew up bits of stout wood, to make into paper for her nest. When one thinks of the size of her head, one wonders where she carries the muscles to operate these implements.

Between this wasp's forelegs is stretched a section of a wasp's leg very much enlarged.

Below is a white-faced wasp sitting outside its amazing house.

The paper wasp above will not sting you unless you bother her, but she doesn't like to be disturbed, for she's busy about her nest.

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cited "yellow jackets" may be seen bustling in and out of the city gates. These big cities are usually built underground or inside an old hollow tree; but smaller nests, in which small family parties live together, are often hung from the branches of trees or under the eaves of an outbuilding.

### The First Paper Makers

Every nest, large or small, is started by a queen wasp who has managed to live through the winter. Alone, she chooses

as well as paper and building cells to make. She must go out hunting, too, for the wasp babies need fresh meat if they are to grow up into strong, healthy yellow jackets. So the mother wasp darts out of the nest, chasing and catching flies, tearing off their wings and heads and feet, and making them into a kind of fly mash for her young ones.

In a few weeks she is surrounded by many willing helpers. She ought to be very glad to see the first young yellow jackets

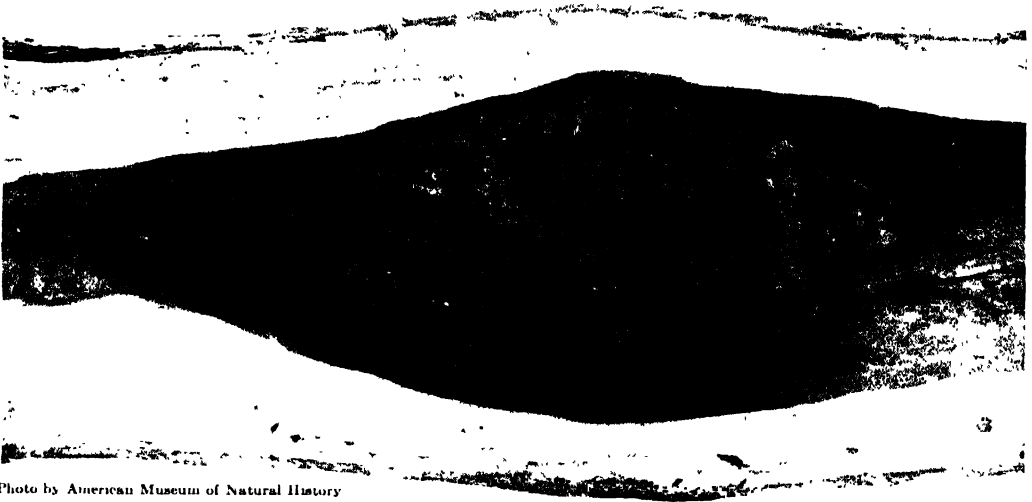


Photo by American Museum of Natural History

It would be hard to find a safer place for a home than in the heart of a tree. And as is often the case when

a house is built, the material excavated has here been used in the construction of the residence.

her building site and lays the foundation of her home. Her first care is to build a few brood cells. These she makes, not of wax, but of paper—and she also makes the paper itself, out of chips of wood torn from an old dry fence or tree stump. She takes tiny fragments in her mouth and gnaws and chews them into a soft, pulpy mass that she can easily mould into shape. When it is dry, it makes a kind of tough, waterproof paper. Then the wasp lays her eggs in the cells, which hang downward from the roof of the nest under a protecting cover like a small paper umbrella. She goes on making more cells and laying more eggs until the first brood of wee wasp grubs is hatched.

And then the queen wasp has to work harder than ever. She has babies to feed,

break through their cocoons! The new wasps are workers, not queens like their mother; and they do not lay eggs, although they share in all the other work of the wasp city. They make paper, build cells, hunt flies, and feed the babies, who open their wee round mouths like young birds when the nurses come around with their food.

### What Happens to Wasps in Autumn

So day by day the city grows, and the workers are kept busy from morning until night. Then, toward the end of the summer, they build some very big cells in which to rear the drones and queens. The drones and young queens soon leave the nest, and as the days grow colder, the workers grow tired and listless. They stop working and stay at home more and more. Since they

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have no food for the babies, they drag the poor little things from their cells and fling them out of the nest. Then the workers die, for their task is done. When winter comes not one of all the busy throng is left alive in the wasp city.

Solitary wasps, or "digger wasps," as we call them, live alone like the solitary bees. There are no worker diggers, but only males and females. Each little female wasp digs her own nest and stores it with food for her children. Some diggers make nests of mud and fix them securely under rocks or leaves or the eaves of buildings; others bore tunnels or winding galleries in the ground or in the side of a hill or sandy cliff.

The salt marshes of San Francisco Bay are favorite nesting grounds for some of these little wasps. On a warm September day there, you may see numbers of them as busy as they can be on the bare salty patches that glisten white in the sunshine among the low-growing plants.

The digger works with furious haste, scraping and kicking in the ground with her feet, biting out little lumps of salt crust and throwing them some distance away from her hole. When she has dug out a little tunnel some three inches deep, she carefully covers up her work with a small pebble or a bit of salt crust, spreads her wings, and flies away.

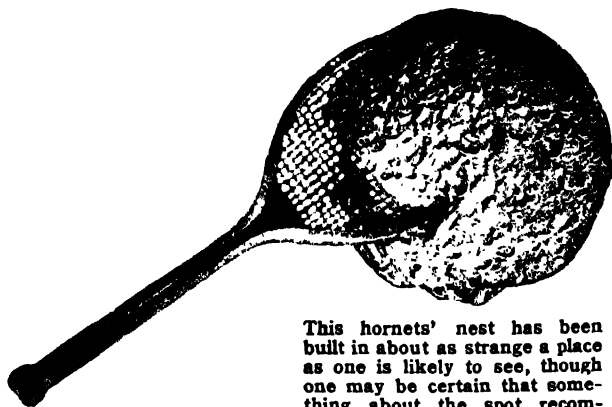
A few minutes later she comes back

again, clasping tightly a long, limp caterpillar as big as herself. She drops her burden outside the entrance to her tunnel, removes the pebble, and drags her victim down below. When she has captured from five to ten caterpillars—the number varies with their size—and dragged them into her nest, she lays an egg on top of them and carefully closes the tunnel with pellets of earth and a small slab of salt crust, so that there is nothing to mark the spot where her precious egg lies hidden.

### Fresh Meat for the Children

Now the most wonderful thing of all is that those caterpillars are not dead. If they were, they would be no good to the little wasp grub when it came out of the egg. The little creatures must have meat that is perfectly fresh. So the astonishing mother wasp does not kill the caterpillars, but only stings them in exactly the right place to paralyze them; so they live on, but lie helpless and motionless until such time as the wasp grub is ready to eat them.

There are many different kinds of these amazing little solitary wasps. Although they all feed on nectar and fruit juices, they all provide fresh animal food for the children that they never see. And while some stock the nursery larder with caterpillars, other store the nests with beetles, grasshoppers, locusts, crickets, flies, cockroaches, or spiders.



This hornets' nest has been built in about as strange a place as one is likely to see, though one may be certain that something about the spot recommended it to the builders.

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## Reading Unit No. 5

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### THE BUSY AND CAPABLE BEE

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How bees spend the winter, 3-  
310-11

The duties of worker bees, 3-311-  
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The way in which a beehive in-

creases in population, 3-312-  
13

The worker bee, 3-313-15

How bees make honey, 3-314

The queen of the hive, 3-315-18

Modern beehives, 3-320

#### *Things to Think About*

What kind of people will bees tolerate?

How are young bees taken care of?

What are the tools of the worker bees?

What steps are taken to ensure

a new generation of bees for the following year?

What happens in a beehive before and after swarming takes place?

In what way do bees help flowers?

#### *Picture Hunt*

How many bees live in one beehive? 3-309

How can you recognize a queen bee? 3-310

How do bees carry pollen from flower to flower? 3-310

What happens to a honeycomb in the hive? 3-312

How do bees make honey and wax? 3-313

What are brood cells? 3-314

What do beekeepers do when bees swarm? 3-315

What do modern beekeepers do to make their work easier? 3-  
316-17

#### *Related Material*

How do bees and other insects help plants produce seeds and fruits? 2-107-14

What other insects besides the honeybee live in communities? 3-320-27

#### *Leisure-time Activities*

PROJECT NO. 1: Visit an apiary and learn all you can

about the life of the bee, 3-309-  
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#### *Summary Statement*

The queen bee's only duty is to lay the eggs that will turn into workers, drones, and new queens. She is attended by workers who guard, clean, and feed her, take care of the eggs and grubs, build

the honeycomb, collect nectar and pollen, and make honey and wax. Bees carry pollen from flower to flower and thus help in pollination.



## THE BUSY AND CAPABLE BEE



Photo by U. S. Department of Agriculture

The modern beekeeper houses his bees in model hives like these. Each contains frames for the honeycomb, each frame made so that the keeper can take it out whenever he pleases. The beekeeper in the picture

is looking for cells which will produce queen bees. He has to keep close watch of the inhabitants of each hive. In the summer each colony should have one queen, about 200 drones, and perhaps 90,000 workers.

### *The BUSY and CAPABLE BEE*

*When You Have Read This Story of the Bee, You Will Begin to Wonder Whether This Touchy Little Insect May Not Be Almost Human*

**C**OME out with us on a sunny April morning into a quiet Old-World garden where, in a warm sheltered corner, stands a row of bee hives, for we are going to watch the little winged folk beginning their season's work.

"Oh! but bees sting," perhaps you say in rather anxious tones, as if not quite relishing the invitation. Yes, certainly bees will sometimes sting, if they are frightened or vexed or being hurt; but that is no reason why you or I should be stung, provided we do nothing to annoy the little people. After all, we too do not appear at our best when alarmed or angry or in pain, and though we have no stings, we are likely to be quite unpleasant under such circumstances. So let

us put a bold face upon our adventure, forget all about that matter of the stinging, and go down into the garden simply thinking what beautiful and wonderful creatures we are going to watch.

Now bees are most remarkable insects, and quite extraordinarily human in their likes and dislikes; so we must be careful to be on our best behavior when we visit them. Bees simply detest dirty, unwashed people, or people who make use of strong-smelling scents. They loath noisy, rowdy, clumsy people who shout and jump about, knocking against the hive or trying to hit out at an approaching insect. They hate untruthful people who say they are not a bit afraid of bees but are really watching and suddenly

## THE BUSY AND CAPABLE BEE



Photo by the A. I. Root Co.

Here are top and side views, somewhat enlarged, of the three kinds of bees that make up the colony in each hive. At the left is the worker, who, though the smallest of them all, yet does all the labor and gov-

erns the hive. In the center is the drone, idle and useless except as a suitor to the queen. And at the right is the queen herself, who pays for her royalty by spending nearly her whole life indoors.

shifting about in alarm at the first sign of one. All such folk had better keep as far away as possible, for the honest little bees will certainly recognize them and sting them, if they see them near the hives.

But people who are clean in body and in mind, who are quiet and gentle and love all Nature's children, seeking to know and understand their ways, these people the bees will welcome as their true friends. This is not a fairy tale; anyone who has kept and loved bees, and has watched their ways, will tell you the same story. They will also tell you that although every beekeeper gets an occasional sting, in nine cases out of ten it happens because the bee has been hurt or alarmed in some way or other.

All through the long, dark, and cold winter months the bees have for the most part kept close within the hive, tightly packed to-

gether at its very center for warmth. They came out only for a short cleansing flight when a sunny morning and a rise of temperature made it possible.

But many a bee goes forth on such a flight never to return; it is overtaken by cold and storm before it can regain the safe shelter of the hive. At regular intervals, too, they have drawn upon their food supplies stored within the hive, not eating greedily, but just enough to keep life going; and

always the queen mother of the hive has been kept in their midst and carefully guarded from cold. This they know is most important, for were the queen mother to die during the winter, their community would soon cease to exist, for it is she alone who can produce the eggs

from which the spring brood of workers will arise.

Worker bees are not very long-lived little



Photo by Cornelia Clarke

The workers not only carry home nectar from the flowers and make it into honey, but also brush their hairy bodies against the flowers' pollen and thus carry it from plant to plant.

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## THE BUSY AND CAPABLE BEE

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Photo by Nature Magazine

How should you like to be this beekeeper, with your arms wrapped around a swarm of bees and not even a bee veil to protect your face? It would not be a

good plan to imitate him unless you know a good deal about handling bees. But if you understand the little insects, you can do this without feeling a single sting.

people; those that are hatched in the autumn live the longest, for they survive through the winter and carry on until the spring brood matures. But the bees that are born in the spring and summer only live a few weeks; for they work so hard bringing in the stores of pollen and honey, and carrying on all the other duties of the hive, that in three or four weeks they are quite worn out and die. Still, although their life is so short, for these summer bees it must be a happy one, filled with glorious hours of sunshine and the scent of flowers and the joy of unselfish labor; for they all are working for one another's benefit and for the welfare of the hive.

### When Spring Ends the Bees' Long Rest

—As we have said, throughout the winter the bees kept snug and silent within the hive—unless one were to believe a beautiful old story that at dawn on Christmas morning

they awaken and sing in honor of the infant Christ. But now the bitter cold of the snow and frost has gone; all the land is green again, and the glad song of the bees rises from every hive as the little insects awaken to full activity once more. With the return of the grateful warmth and sunshine the bees start to work with tremendous energy upon a thorough spring cleaning of the hive. While some fly forth to fetch water from the nearest brook, others are hard at work upon the combs, cleaning them and repairing any parts that need attention. Still others are carrying away to a little distance from the hive the dead bodies of their comrades who perished during the winter months. During every hour of sunshine there is a constant stream of bees going forth to the fields and hedgerows to seek nectar and pollen from the opening spring flowers, and within the hive the comb builders are hard at work constructing new cells in which to store the

## THE BUSY AND CAPABLE BEE

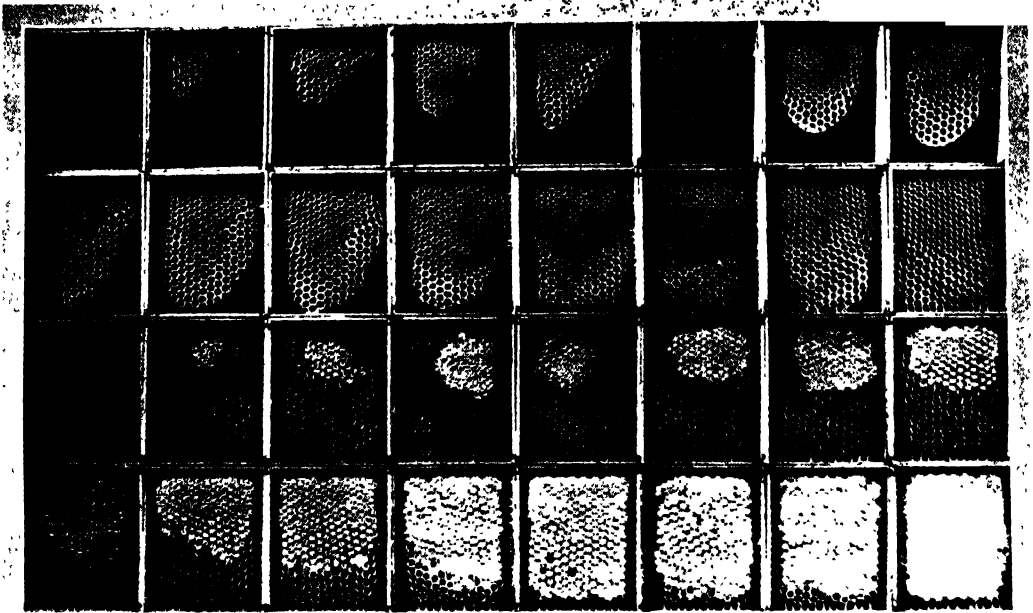


Photo by American Museum of Natural History

This series of pictures shows successive stages in the formation of a honeycomb and in the filling of its

numberless little six-sided cells with the rich honey you like so much on your biscuits.

freshly gathered spoils, and also making new brood cells in which the queen mother will lay the first eggs of the year.

### Her Majesty, the Queen

All through the cold winter months, the queen mother of the hive has remained practically dormant in the midst of her offspring, the workers, who have carefully guarded her. Now as spring advances she gradually resumes her duties. At first she lays only a few eggs daily, but as the days grow warmer and longer, and the combs are rapidly filling with honey and pollen brought back from the open fields by the busy workers, her output steadily increases, until in the height of the honey harvest she may lay, it is said, some fifteen hundred to two thousand eggs per day. But the number is regulated exactly to the need of the hive and the ever-watchful workers will ply the queen mother with stimulating food, or reduce the amount given to her, so that her egg production is increased or decreased as may be necessary.

Wherever she goes within the hive the queen is attended by a company of workers

who not only feed her, but, when she is busy about her egg laying, keep watch to see that she deposits only one egg in each cell on the brood comb. Should she accidentally drop two into a cell, one will instantly be removed by the attendant workers. The eggs are very small, oblong, and pearly white, and are always the same in outward appearance, no matter whether the life germ within develops in the end into a queen, a worker, or a drone. Whether the baby bee shall become a queen or a worker depends entirely upon the amount and kind of food supplied to the little insect during its infancy.

### The Beehive's Nursery

As soon as the egg is laid, a supply of food is placed beside it in the cell by the worker bees, so that on hatching, the little legless, maggotlike larva may find a meal all ready awaiting it. The food supplied for this first meal is of a very special character; and according to whether the little larva, or bee baby, is to become a queen or a worker, it will be given more or less of the "royal jelly," as beekeepers often call it. If it is to become a perfect female, or queen, capable

## THE BUSY AND CAPABLE BEE

of laying thousands of eggs, then the little creature will be fed entirely upon this special food throughout her larval life; but should it be intended for a worker, then it will receive the special food during only the first and second days of its larval life.

After this the baby worker bee is fed on a plain diet, chiefly honey and pollen, until it is ready to change to a pupa. Then no more food is taken, and the little creature lies quiet and still within her waxen chamber while she is being transformed from a helpless grub to a perfect bee with six legs and two pairs of gauzy wings.

The young drone is treated exactly like his sister, and receives the same kind of food as she does.

Three days after the queen mother has deposited an egg in a cell in the brood comb, the baby grub, or larva, hatches out. If it is to become a worker or a queen, its larval stage lasts for eight days; but a drone baby continues to feed and grow fat for two days longer before it is ready to turn to a pupa. So after eight or ten days, as the case may be, the nursemaid bees, whose duty it is to look after the eggs and the babies, seal up the nursery cells with a porous cap of wax and pollen, and leave their charges to rest undisturbed while the wonderful transformation is going on.

### The Bee's Silk Sleeping Bag

As soon as the nursery cells are closed, each little prisoner spins for itself a silken sleeping garment, or cocoon (kō-kōon); then it rests for a day or so before it casts its larval skin and turns into a mummylike thing called a "pupa" (pū'pā). A future queen becomes a pupa two days after she

has been shut up by her nurses; and when six more days have passed she is quite ready, if she is allowed, to come forth as a perfect insect. A worker baby does not cast her larval skin until three days after her cell has been closed; then she waits ten days longer, tightly swathed in her pupa case,

before she completes her transformation. The drone

waits for four days before changing to a pupa; then, like his sister, he also rests for ten days before he is ready to come out into the world.

The little worker bee is really a most remarkable little person, equipped with a marvelous array of tools and devices to aid her in all the different kinds of work she undertakes in her short and busy life. Each worker bee has:

A sucking tube for drawing up nectar from the flowers.

A honey bag, or crop, to carry the honey home in.

Pollen baskets of stiff bristles on her hind legs to hold the pollen she gathers.

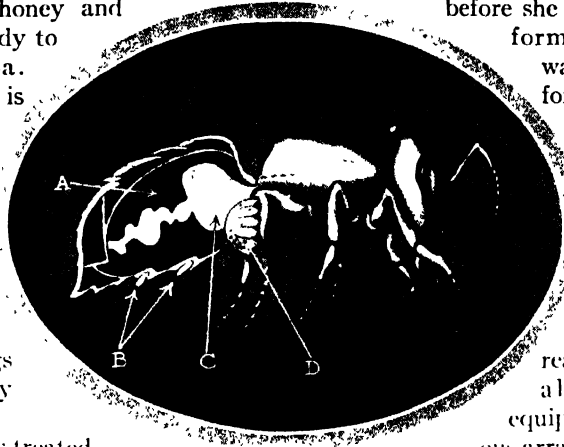
Neat little combs on her hind legs to help her collect the pollen, and handy little brushes on all her legs with which she keeps herself neat and trim

A strong pair of shears for cutting and moulding wax when she is busy building her comb.

The bee's shears are her jaws—two strong, sharp blades which work sideways like a pair of scissors.

Her sucking tube is really a long under lip, which looks somewhat like an elephant's tusk. It is made up of several slender parts that fit together to form a tube, and has a wee, hairy pad at the end of it with which the bee mops up the honey.

Then the worker has several glands under



Here is a diagram to show some of the marvelous mechanisms of a worker bee's body. She draws up the nectar with her sucking tube, and turns it into honey by means of special glands in her mouth; then she stores it in her honey sac (C) until it is needed, when she disgorges it. She has wax glands, too, which make the thin wax wafers (B) that come out on her abdomen. Of course she has a stomach and intestines, shown as an irregular white tube in the large abdominal cavity which is marked A. At D is another capacious receptacle in which the bee carries pollen.

## THE BUSY AND CAPABLE BEE

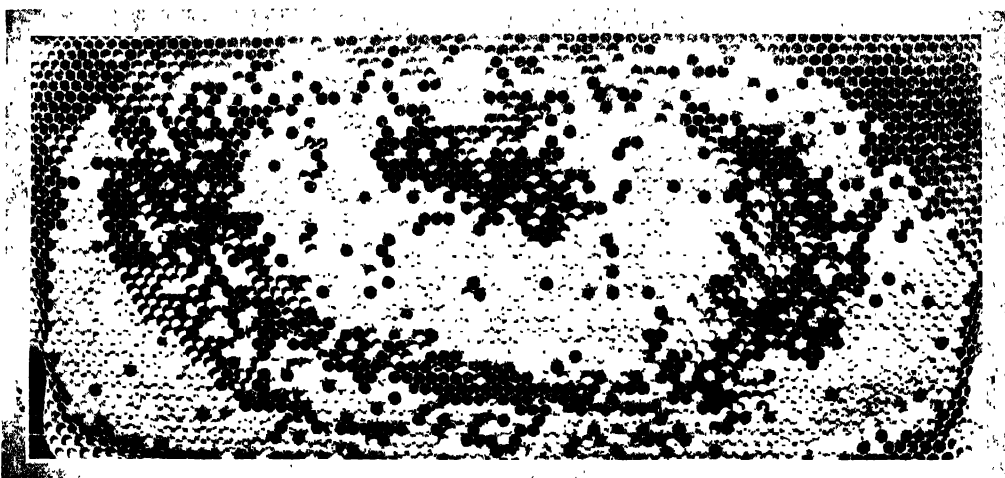


Photo by U. S. Department of Agriculture

This is a section of brood comb, where the new generation of bees will turn from larvae to pupae and then to full-grown workers or drones. We notice that the

brood cells are arranged in rings. The queen begins at the center of a comb when she is laying eggs and works outward in widening circles.

the skin of her little body to produce wax to build combs with and a number of little pockets, or openings, down her sides through which the wax appears in delicate wafers—like so many tiny pocket handkerchiefs.

### How Bees Make Honey

She has other glands in her mouth from which flow juices which change the nectar she swallows into honey before it reaches her crop; they also convert honey and pollen into royal jelly to feed the princesses and the newly hatched baby workers.

Lastly, every worker bee is armed with a sharp poisoned dagger with barbed edges. With this she defends herself and the hive against all comers.

The bee's sting is a most wonderful weapon. It is like a tiny sword with three blades, and at the base of the sting is a poison bag. When the bee is working peacefully the three blades fit closely together, but when she stabs an enemy with her sword the blades separate and at the same time they are drenched with a burning fluid from the poison bag. And this it is that makes a bee's sting so painful. But the valiant little insect uses her sting only as a last resource, for the barbed edges of the blades often prevent her withdrawing the delicate weapon from the wound it has made. And when a bee loses her sting she dies.

Now the little worker bee, on completing her transformation, comes forth from the shelter of her nursery cell and is at once fed and cleaned by the nurse bees—after which for a day or two she is permitted to wander about the interior of the hive, that she may become familiar with its contents and learn where are the store chambers of reserve food, and where the brood combs hang. Even during these few days of comparative freedom, the only holiday she will know during her short life, she is learning the ways of the hive; and once this brief holiday is over she will enter upon a life of unceasing labor and service to the community, until, worn out with work, she dies.

### How Worker Bees Start Life

She generally begins her life of toil as a nursemaid, for it is during the earlier part of her life that she can best work up in her crop the predigested jelly food for the queen and the babies. Later she will go forth into the warm, sunlit, fragrant fields to gather nectar and pollen from the flowers. Or she will take her turn to act as a living fan, clinging with her feet to the alley ways inside the hive and, in company with her sisters, fanning her wings with all the power she can muster to produce a steady current of air circulating through the hive. In this way she helps to keep the hive sweet and

## THE BUSY AND CAPABLE BEE

cool, no matter how hot the day or night outside; for some of the bees are always stirring during the short, hot summer nights.

She will help, too, in the important work of making wax and building new comb.

With a great mass of her fellow workers, who all cling together in a cluster in a dark corner of the hive, she waits patiently while the delicate wax wafers are formed by her wax glands. Then, when her pockets are filled, she leaves her place in the cluster to help the comb builders to knead and mould the wax and fashion the tiny six-sided honey and brood cells.

The new worker has also to take her turn as a guard at the entrance to the hive, ready to challenge, and if need, be, to engage in mortal combat with a robber bee or wasp that dares seek entry. So morning, noon, and night, with only the briefest pause for food and cleansing, the little worker bee toils on until at last with torn wings and worn-out body, she falls by the way, perhaps on some last journey from the hive in search of pollen or nectar.

As the spring days glide toward early summer, the worker bees construct, on the margin of the brood combs, somewhat larger cells in which the queen mother will deposit the eggs destined to produce the drones, or male bees. The drone is much larger than the worker bee. He is a big, useless, blundering fellow and no favorite in the hive. He just eats and sleeps and buzzes about, getting in the way of the worker in the most exasperating way. Yet the drone is not altogether to be blamed for his laziness,

for he could not work for his living even if he wished to. The drone has no tools of any kind—no sucking tube, pollen baskets, or honey bag, no brushes and combs on his legs, and no sting. He is a most helpless

creature. He cannot even feed himself very well, as his tongue is too short to reach the nectar in the honey tubes of the flowers. So the drone greedily eats up far more than his share of the honey and pollen stored in the hive, and is forever following the nurse bees and the queen's attendants about, worrying them to give him royal jelly.

Very soon after the drones have begun to appear, the workers start building a few royal cells in which to rear future queens. These nurseries are much larger than those of the workers and drones, and are quite different in other ways. In size and shape they somewhat resemble an acorn. Five or six of these royal cells may be made and hung mouth downward either at the center or on the sides of the brood comb. Unlike the worker the young princess, or future queen, on completing her transformation is not permitted at once to quit the royal nursery. She is kept a close prisoner and fed

through a small hole in the wall of the waxen cap, or door, of her cell. Only one queen can reign in a hive at a time, and when the old queen mother hears the shrill piping of the imprisoned princess, and realizes the presence of a rival, she grows extremely angry and excited, and could she reach the royal nursery she would at once slay her offspring. But she is prevented from doing



Photo by American Museum of Natural History

When a swarm of bees leaves the old hive, they usually alight on a branch of some tree, as these have done here, with their queen in the midst of them. Unless they are wild bees, the beekeeper will be ready for them. He will bring them a hiving box and gently shake or brush them into it; then he will give them a new hive in which to set up housekeeping.

## THE BUSY AND CAPABLE BEE



Photo by U. S. Department of Agriculture

The old-fashioned dome-shaped beehive was picturesque but not very practical. Nobody could get at the contents except the bees, or even get a look inside to see that all was going well; the only way to get out the honey was to destroy the hive. With the new

this by a guard of workers who bar her way, and indeed treat her for once with scant courtesy. The old queen becomes furious, and her excitement spreads throughout the hive, so that all normal routine and labor comes to a standstill. In fact, the hour for "swarming," as it is termed, has arrived. The bees rush in and out of the hive, swirling round in clouds like puffs of smoke. They rush up into the store chambers and gorge themselves with honey, and finally the old queen mother, in the midst of a great swarm, quits the hive and flies away to start a new colony.

### The Marriage Flight of the Queen

Once the swarm with the old queen has departed, the little princess is allowed to come forth from the royal cell and wander about the hive for a day or two. Then on a warm, still, sunny morning she comes out on the alighting board, and there pauses for a few moments to accustom herself to the strong light. For a while she hesitates, as if afraid to leave the shelter of the hive. Then, gaining courage, she rises on outspread wings

type of hive, on the other hand, the beekeeper can keep close track of everything that goes on, can help the bees with their work, treat any diseases they may have, and get out the honey they do not need without injuring the hive or upsetting the bees much.

and slowly circles round the hive, as if carefully to learn its exact position. Suddenly growing bolder still, she darts aloft and mounts up and up into the deep blue of the cloudless summer sky on her wedding flight.

### The Queen's Unhappy Consort

The drones from all the other hives round about at once sense her going, and with deep booming hums are off and away in quick pursuit. Up and up flies the young queen, and up and up the drones follow her; for somewhere, far out of sight in the summer sky, the queen will wed the strongest and swiftest of them all.

One by one the drones tire and drop out of the race, until at last only one is left. But the victor's hour of triumph is short, for after a swift, joyous marriage flight with the queen, the poor exhausted drone comes tumbling back to earth, a little crumpled corpse.

Soon afterward the young queen, who has been "maid, wife, and widow" all in a single day, comes down from the sky and returns to the hive. She left but a short hour ago,



## THE BUSY AND CAPABLE BEE



Photo by U. S. Department of Agriculture

This peaceful scene shows a modern apiary (ā'pī-ā-ri)—a place where bees are kept. There are many of them in California, where the climate is favorable and

there is an abundance of sweet-scented flowers. Elsewhere, beekeepers usually set up their hives near fields of clover or buckwheat.

almost unnoticed save by the guardians of the gate. Now she is welcomed and acclaimed with every mark of joy and affection. The workers crowd around her, offer her food, brush her and smooth her all over, and stroke her gently with their feelers. For now she is the Queen Mother, the most important person in the hive.

### Death for a Rival Princess

But should there be any other princesses still shut up in the royal nursery cells, the new queen refuses to settle down quietly to her work of egg laying. She will not rest while there are any possible rivals for her proud position in the hive. So if the workers decide that no more swarms are necessary, they stand aside while the jealous queen tears open the cells and stabs her sisters to

death with her long curved sting—which, by the way, is not poisonous. And after this one savage act the new queen calmly takes up her duties without any more fuss; and unless she herself leads a swarm, as the old queen did, she will never again leave the hive.

The queen bee has—for an insect—a remarkably long life. She may live for four or five years; but she is seldom allowed to grow so old. For directly the workers see that her powers of egg laying are beginning to fail, they kill her. They do not slay her swiftly by quick thrusts from their poisoned daggers—the bees are not allowed to sting their queen. But they crowd round her, pressing closer and closer until she is squeezed to death.

The bees are ruthless little people. They

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## THE BUSY AND CAPABLE BEE

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care only for the general welfare of the hive. No worn-out, useless, or lazy member of the community is permitted to live within its walls. We catch another glimpse of the way this relentless law is carried out in the sad fate that overtakes the lazy drones. Their life is a short and a merry one. All through the bright summer days they are fed and housed and suffered to do as they please by the stern little workers, simply because one or two of the gay and idle band may be required as mates for new queens. But when the days grow shorter, and there are no princesses left in the hive, the workers suddenly turn upon the bewildered drones, drag them to the gateway, and after biting through one wing so that they shall be unable to fly, they push their unhappy brothers over the edge of the alighting board. There they are left helpless upon the ground to perish from cold or hunger, or be devoured by insect-eating birds. Then the workers go to the brood combs, and if any drone babies are left in the nursery they are taken out of the cells and cast out of doors—there to meet the fate of the grown-up drones.

This wholesale slaughter of the drones is carried out without mercy by the ruthless little workers so that there shall be no idlers left in the hive, to take toll of the stores carefully laid up to carry them through the long, lean days of autumn and winter. All the food will be needed to keep life in the little bodies of the important worker bees until spring returns, and they are able, once again, to fly out into the sunshine to gather fresh stores of honey and pollen.

### How Bees Make the Flowers Bloom

But let us turn for a moment to look at the brighter side of bee life, the side which is intimately lined up with the welfare of mankind; for upon the success of the labors of the bees in the fields and orchards depends the amount of seed and fruit the farmer shall harvest when autumn comes. Throughout the spring and summer both the honeybees and the big wild bumblebees have been hard at work. Not only have they been collecting nectar to store in their combs, but in visiting the flowers for this purpose, they have been

the natural means of carrying the precious golden pollen from flower to flower, that the seed may be set. If there were no bees there would be little or no fruit in the orchards, and in a year or two the majority of both wild and cultivated flowering plants, including the clovers and other important crop plants, would cease to exist, for they are entirely dependent upon the visits of the bees to bring to them the pollen that is necessary for the fertilization of their seed.

And now let us look a moment at a modern standard frame beehive. It is a stout wooden home built specially to meet the requirements of the bee community, and consists of four parts, all of which are not only movable, but of standard size and so can easily be replaced or added to. The first or bottom section is the floor board, which has four short, stout legs and, in front, a sloping alighting board for the bees to land upon as they return laden with spoils from the fields. The second section is the brood chamber, in which are located the brood frames and division board. The third section is called the super-rack, or section rack, and is built to hold the regulation twenty-one sections with their wax foundations on which the bees will construct the honeycombs. The fourth or last section is the roof of the hive. In old days when bees were kept in baskets called skeps, the whole of the comb, both brood comb and honeycomb, was produced by the bees, who were thus compelled to waste much valuable time that might otherwise have been devoted to work in the fields collecting honey. Now that is all changed, for in the modern hive the brood frames and the section frames have sheets of comb foundation, made from pure beeswax and inserted before the frames are placed in the hive. All that the worker bees have to do is to produce the delicate thin walls of the cells in the comb. In the modern frame hive the "bee master" has his bees under perfect control. The honeycomb sections can be removed as they become filled and replaced by fresh empty sections for the bees to continue work on; and he can always see what is going on inside the hive, and keep his bees healthy, busy, and happy.

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# WONDERS of the INSECT WORLD

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## Reading Unit No. 6

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### WONDERS OF THE ANT WORLD

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Where ants live, 3-320-21  
What we can find in an ant hill, 3 321  
The life of an ant baby, 3-321-22  
The social life in an ant hill, 3-322-23

The "cattle" of ants, 3-324-25  
Slavery among the ants, 3-325  
Harvester ants, 3-325-26  
The fierce driver ants, 3-327

#### *Things to Think About*

What are the various duties of worker ants?  
What happens when ants "swarm"?  
Why do ants take care of aphids?

What are "honey pots"?  
How do some ants cultivate mushrooms underground?  
Why do driver ants cause every other living creature to flee?

#### *Picture Hunt*

Why is building an ant hill a tremendous task for ants? 3-320  
How strong are ants? 3-321-22  
What can you find in an ant hill? 3-322

How can you study ants at home? 3-324  
How are anteaters fitted for catching ants? 3-326  
Why do large animals flee when they meet driver ants? 3-327

#### *Related Material*

In what respects is the swarming of ants different from that of honey bees? 3-316

How do honey bees treat their drones? 3-318

#### *Leisure-time Activities*

PROJECT NO. 1: To study ants, follow the directions for raising and feeding them on page 3-324  
PROJECT NO. 2: In the summer examine the top of golden-

rod that is infested with plant lice. Using a hand lens, see if you can find out what the ants are doing with the plant lice, 3-324-25

#### *Summary Statement*

Ants are social creatures like the bees. They live in ant hills where they raise their young.

Queen ants do nothing but lay eggs, which are tended carefully by the workers.



Photo by A. Wolfen

Our parasol ant actually half an inch long has carved his umbrella out of a green leaf and is hurrying home with it. At the door of the ant hill a much smaller worker will jump on his back and begin to chew the leaf into tiny pellets, which fertilize the fungus on which the ants all live. Large soldier ants an inch long protect the nest. Their strong jaws are used by South American Indians to hold together the edges of large wounds. After the ant has got its grip the head is twisted off. These same ants are fried by the natives and eaten much as bacon would be.

## WONDERS *of the* ANT WORLD

*Where Thousands of Little Creatures Live in the Cities  
They Have Built and Keep Pets and "Cows"*

**D**EEP in the quiet woods it often seems so still that we feel all alone in the cool, green world. A roof of leafy boughs is over our heads, and the carpet of leaves and moss under our feet is so soft that we can hardly hear our footsteps. But if we imagine we are quite alone, we are surely making a great mistake. There are hundreds of little people moving about. They are here, there, and everywhere; but they make no noise and they are so very small that we seldom notice them. All around, too—right under our feet—are model towns and dwellings, with winding roadways leading in every direction—all made by the marvelous little woodland people we call wood ants.

Funny little beings they are, to be sure, clothed from head to foot in a dull reddish uniform. They have queer, flat heads and long bodies divided into two distinct parts by a threadlike waist with two large knots in the middle of it. Their six jointed legs are very slender, but are long and strong,

and the little owners can run about very fast.

On their foreheads the ants carry a pair of stout antennae (ān-tēn'ē), or feelers, with a sharp elbow joint in the middle. By means of them they communicate with one another in some way that we do not understand. They are armed, too, with a pair of strong sickle-shaped jaws, which are used as weapons for fighting and as tools for working in a hundred and one different ways. These jaws can be worked quite independently of the ant's other mouth parts, which are used only for eating and drinking.

These tiny woodland folk live, like the dwarfs and gnomes of our fairy tales, inside a hill or underneath the ground. If you could make yourself small enough to enter and explore one of those ant establishments, you would be astonished at the wonderful way in which it is arranged, and at the orderly manner in which the little inhabitants behave.

## WONDERS OF THE INSECT WORLD

From the outside an ant hill does not seem highly interesting. It looks like nothing but a jumble of bits of twigs and leaves and pine needles all heaped up together. But some of the heaps may be over two feet high and several yards around; and when we remember that all the millions of odds and ends of which they are built up have been brought here and twisted into place by such tiny creatures as the wood ants, the building begins to be amazing.

Inside the ant hill there is perfect order. Many gateways open into long, winding passages—some going up and some going down—where we might easily lose our way unless one of the ant people acted as guide to show us around. There are rooms and halls and galleries in every direction—living rooms, storerooms, sleeping rooms, nurseries, all as neat and tidy as you please. And in and out and up and down, thousands of busy ant folk are running about, just as throngs of human folk hurry to and fro in a crowded city.

All the little ant people look much alike. They are all workers, but they are not all busy at the same tasks. Troops of them are hurrying off to their day's work outside the city walls—some to fetch in fresh supplies of food, others to collect building materials for enlarging or repairing the roof of the nest. Gangs of outdoor workers are busy clearing the roadways of the bits of stick and rubbish which are always falling in the way, or making new paths for the feet of the little people.

Inside the nest the housemaids are busy tidying up the rooms and galleries, while processions of nurses hurry along the passages carrying little white bundles from place to place in their jaws. These little bundles may be cocoons or they may be the ant babies, which are sorted out according to age and kept in special nurseries.

Besides the swarms of worker ants, in

every large ant city there are always several queens. The queens are bigger than the workers. They spend all their days in the nest and never go out for a holiday or a change of air—they are much too busy laying eggs. A little band of workers is told off to wait upon each queen and act as her maids of honor. They follow the queen about wherever she goes, offer her food, attend to her toilet, and stroke her gently with their antennae—an attention which Her Majesty seems to appreciate.

As fast as the eggs are laid by the queen, they are picked up by the workers and carried away to special egg rooms. There they are watched and guarded until they hatch, when the new ant babies are at once removed to one of the nurseries.

Ant babies are helpless little atoms, very much like bee grubs, only a good deal smaller. They can do nothing but wriggle their fat little legless bodies and open their wee mouths to be fed. The nurses take the greatest care of their little charges. They are always feeding them, cleaning them, carrying them about, or stroking them gently with their antennae. At night the babies are carried down to the night nurseries on the lowest floors of the nest, where they are warmer and safer. Then in the morning they are all brought up again to the large, airy day nurseries in the top of the ant hill. If the day is warm and bright the mites are taken out of doors to lie and wriggle in the sun.

### Trained Nurses for the Babies

When they are full-grown the ant grubs spin wee cocoons and go to sleep inside them. But the devoted nurses still keep fussing about with the little things. They are always carrying the babies in their jaws from one place to another, so anxious are they that the sleeping infants shall be neither too hot nor too cold. Then at last,



Photo by Cornelia Clarke

**Here are David and Goliath. The little ant is dragging the mighty hornet to his nest.**

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Photos by American Museum of Natural History and Cornelia Clarke

The large picture shows an ant nursery. Here are eggs, pupae, and newly hatched ants, all lying on a piece of bark. These are the precious objects that

the ant nurses tend so carefully, and carry to safety whenever danger threatens. The oval shows a mountainous ant hill in Brazil.

when the magic change is complete and the new ants are ready to leave their cocoons, the nurses hasten to break open the little silken cases and help them out.

### How an Ant Begins Life

The new arrivals in the nest are at first very weak and shaky. But they are well treated by the workers, who assist them to stand up on their thin, quivering legs, give them food, introduce them to their comrades, and show them the way about the city. They do no work for the first day or two, but are allowed to wander about as they please. The young ants have no wish to remain idle for long. As soon as they are strong enough to work, they take their places with the other workers and share in all the toil.

So week by week the ant colony increases in size. The little people have plenty to do, enlarging the nest, digging out new rooms, and finding food for the whole popu-

lation. Then, when work is at its heaviest and the summer sun is still high in the sky, an exciting event occurs in the ant city. Instead of wingless workers coming out of the cocoons, swarms of young ants with four gauzy wings apiece make their appearance. They are "queens," or female ants, and "drones," or males. The new ants do not begin to work with the other inhabitants of the city, but loiter about getting in the way of the workers—who must find them a perfect nuisance. But the workers are not annoyed. They are very kind and patient. They offer the idlers food and smooth their wings for them. Then on a still, sultry day, when it must be uncomfortably hot indoors with such crowds of ants about, the winged insects grow very much excited, and with one accord they pour in thousands through the city gates and rise together into the air.

From all the ant hills round about, swarms of winged ants troop out and join the giddy

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throng. Here and there they drift in little clouds, their wings gleaming with rainbow hues as they dance joyously in the sunshine. For this is the ants' wedding flight. The young queens mate and fly away on a short and carefree honeymoon.

But the happy holiday is soon over. A

nest. They are of no use to anyone, and the workers will have none of them. The poor things wander about until they die of cold or are snapped up by the hungry birds.

There are ever so many different kinds of ants. All over the world the determined



Photo by F. Martin Duncanson

Here are two ants carrying an egg. It is much larger than they, and an awkward thing to carry at best.

But if you watch them at it sometime, you will find that they get it over the ground with amazing speed.

sad fate overtakes most of the revelers. All the birds in the neighborhood pursue the dancing ants and gobble them up by hundreds and thousands as they sink exhausted to the ground.

After these adventures, the few young queens who escape the general slaughter seek shelter where they may. Some, with the help of a few workers, soon start new nests of their own. Others creep back into the old home, where they are welcomed and kindly treated by the little citizens.

### After the Honeymoon

The queen ants never have another holiday. From now on, like all the other members of the city, they have work to do. They spend the rest of their days laying eggs to keep up a strong and thriving population for the city. And before settling down to her duties, every queen tears her beautiful wings away from her shoulders—she will never fly again!

As for the drones who were not eaten up at once, their fate is certainly a sad one. They are never allowed to go back to the

little insects make their nests and build up their cities, wherever it may suit them. In the woods and in the meadows they raise their hills or tunnel into the ground. Some of them set up housekeeping in old dry logs or tree stumps, hollowing them out with their strong jaws. A few make delicate paper nests or live inside bunches of leaves all fastened together with silk; and some invade our houses, where they are a pest.

### Even Ants Have Their Bandits

The little robber ants live, like bandits, by raiding the nests of the industrious tribes and carrying off the grubs and stores. They are so very small and hard to see in their dull, yellowish suits that they often live and carry on their thievish pranks right inside the nests of the larger ants without being detected and punished as they deserve.

They make narrow, winding passages in the walls of the nest, far too small for the big ants to enter. There they lurk, watching and waiting for a moment when the busy workers will be off their guard. They rush out, seize any grubs and cocoons they can

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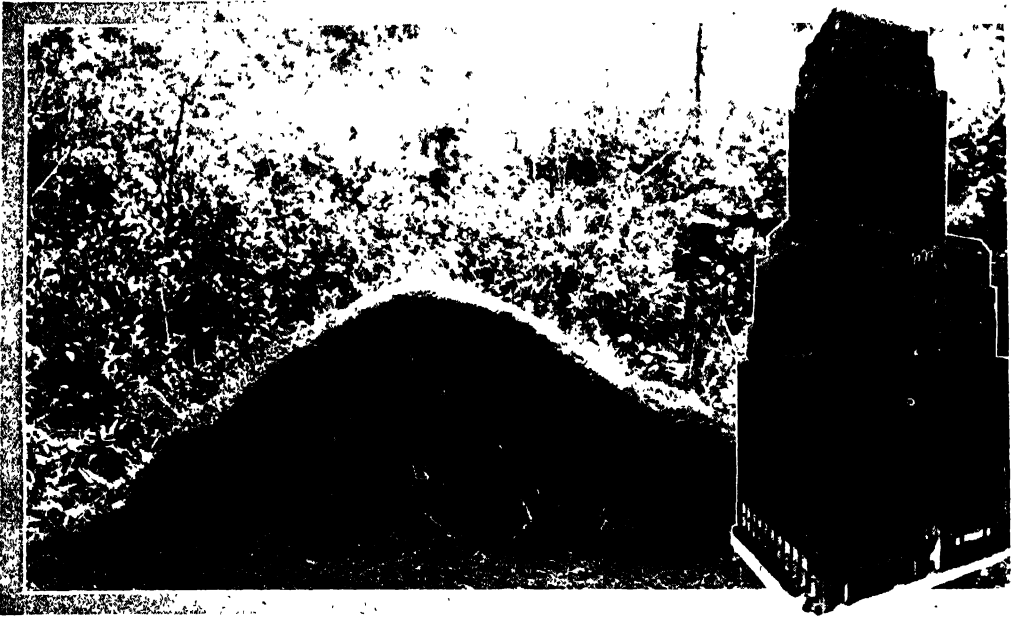


Photo by American Museum of Natural History

If you will think a moment you will see that this is really the picture of two ant hills. The one at the left was built in Westfield, New Jersey, by busy little insects called mound-building ants. It has been cut in two in order to show what it is like inside. You may keep an ant hill on your own table and watch its inhabitants. Just fill a fruit jar about two-thirds of the way up with earth from the garden. Then around the outside of the jar fasten a strip of heavy brown wrapping paper just wide enough to come up to the top of the earth. Find an ant's nest and catch as many ants as you can—you must not hurt them—and dig out of it the grubs and cocoons. You may even have the luck to take their queen a prisoner. You

may know her because she is so much larger than the rest. Now put all your little captives, with their precious grubs and cocoons, into the jar of earth and cover the top of the jar with a paper full of good-sized pinholes to let in air. Set the jar in the sun for a week, and every two or three days feed your captives with sugar, tiny bits of cooked meat, or dead insects. When the earth begins to get dry sprinkle it with a few drops of water. It should be kept moist but not wet. At the end of some ten days you may slide the paper cover off the jar, and there are your ants busily at work in the tunnels they have made against the glass. Be sure to put the paper back on the jar after you have watched them a while.

grab, and scamper back into their holes where the angry workers cannot follow and save their children from being a feast for the bandit.

### The Ants' Queer Cows

There is no end to the curious habits and customs of the ant people. Some ants allow strange insects to live in their nests as honored guests, although they give nothing in return for their board and lodging. Others actually make pets of certain little blind beetles, whom they treat with the greatest kindness and affection. And it is quite a common thing to find large herds of plant lice kept and tended as domestic animals, or ant cows, by the workers in the ant cities.

Plant lice—or aphids (ā'fd)—are those

tiresome little insects that swarm in countless numbers on plants of all descriptions, sucking out the juices with their sharp, piercing beaks and draining the life from the plants. They are such greedy little creatures that they suck and suck until their tiny bodies are swollen into balloons and the sweet juice oozes out of them in sticky drops called "honeydew."

### The Shepherds Tend Their Herds

The ants, who love sweet things, are very fond of honeydew. So they collect large quantities of the little pests and pasture them carefully on suitable plants around their nests. The workers guard their cows from the attacks of other insects, build sheds over them to protect them from the rain, and regularly milk the herds,



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All these cows are being milked. Those in the big picture are ants' cows, or plant lice, which the



Photo by Cornelia Clarke

enterprising ants pasture near their homes and milk for a sweet liquid the queer cows contain.

gently stroking the bulging sides of the insects with their antennae to induce them to yield the sweet, sticky stuff with which they are almost bursting. The ants even collect the eggs of the plant lice in the autumn and keep them in their nests through the winter. When the eggs hatch in the springtime, the ants take their little cows out of doors to feed on the plants that suit them best.

### Honey Pots That Are Alive

The honey ants of North America collect honey from the swellings called "galls" that are made on the twigs of oak trees by small winged insects. A sweet, watery fluid oozes from the galls, and this is lapped up by the ants, who fill their crops with it and carry it home to the nest. There the honey is stored, for the use of the whole community, in a number of large "honey pots" which hang side by side from the roof of the nest. And what do you think these honey pots really are? They are nothing less than worker ants who allow themselves to be used in this extraordinary way for the benefit of their comrades!

There they hang, those strange, long-suffering creatures, clinging to the ceiling by their feet, their hind bodies swollen to the shape of a large currant by the honey with which they are filled. From time to

time the other workers visit their living honey pots and sip the sweet food from their lips. And this is the

only way in which the patient insects enjoy the society of their fellows. They never go out of the nest. Indeed they are too heavy and bloated to walk about; and if they fall from the ceiling, as sometimes happens, the ordinary workers run to their assistance and help the poor things to hang themselves up again!

Several tribes of ants keep slaves to work for them. Well-organized troops of determined little warriors raid the nests of other tribes and, after a desperate fight, carry off the grubs and cocoons in triumph. They certainly treat their little captives well. They look after them as carefully as if they were their own children; and when the prisoners grow up they live in the nests of their owners and work for them quite contentedly. In some cases, indeed, the slave owners grow so lazy that they depend almost entirely on their slaves. The captives do all the work and in time grow so important that they practically rule the city.

### The Thrifty Harvester Ants

The harvester ants that live in large or small colonies on the great western plains of America are wonderfully thrifty in their

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way. They gather the grains and seeds of the grasses and store them up for winter, when the supply of food out of doors grows short. They keep their stores in granaries dug out many feet below the surface of the ground; and the soil they excavate is piled up in a large mound over the top of the underground nest. All around the mound the ants cut away the grass, making a large circular clearing. They also cut broad, straight roads through the brush, over which they can carry their loads home instead of having to struggle through a thick mass of tangled scrub.

### Ants That Carry Parasols

There are always two classes of workers in the harvesters' colonies—small ants, called "minor workers," and larger ants with very big heads and huge jaws, called "major workers." It is said that the big-headed "majors" use their strong jaws chiefly to crack the hard grain for their smaller comrades.

There are also major and minor workers among the parasol ants of tropical America, as well as among several tribes of fierce wandering ants called "drivers." The parasol ants construct large underground towns, crowned by the usual hills, in wood districts or in coffee or orange plantations, where they often make themselves very troublesome by stripping the trees of their foliage. Day after day long processions of the unpleasant insects may be seen making their way over well-worn paths to clumps of their

favorite trees. Up the trunks they go, and in next to no time the little wretches are swarming all over the branches, clipping away at the leaves with their strong, sharp jaws.

Each ant cuts out a fragment of leaf as big as itself, or bigger. Then, holding this aloft in its jaws, it comes down the tree and marches home with its prize. It is one of the funniest of sights to see these strange little creatures parading home, one behind another, in an almost endless procession, every one of them holding its piece of leaf above its head as if it were carrying a bright green parasol to shield it from the sun. All day long the diligent insects travel back and forth between the nest and the trees they are stripping. So there are always two parades going on at the same time, one hurrying out with empty jaws, the other coming back triumphant with their spoils.

The leaves are all torn into fine shreds and packed into large rooms underground. There they are left to ferment and decay till they form a sort of hotbed of rich leaf mould. On this the ants cultivate a kind of mushroom which they use for food.

The worker minors who stay at home and



Photo by American Museum of Natural History

He so enjoyed eating ants that Mother Nature equipped this lesser anteater in the very best way to catch them. He spends most of his time in trees, which he finds it very easy to cling to with the help of his long, skillful tail. This is scaly at the end and may be wrapped right around a limb. His snout is tubular, and from it he can run out that long, agile tongue, which is covered with a sticky saliva. When it is nicely covered with insects he draws it in again and enjoys the catch. In color he is yellowish white and black; and he lives in South America.

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act as nurses bite off tiny pieces of the mushrooms and pop them into the open mouths of the ever-hungry little grubs. It seems a strange kind of infants' food, but ant babies seem to enjoy it and thrive upon it.

Very different in their ways are the fierce driver ants of Brazil and their equally fierce cousins of the African jungles. Although they usually have some sort of settled home as headquarters, they are very restless creatures, always wandering about and setting new camps in any convenient spot where they happen to be when they halt for a rest.

An army of driver ants marching across country is one of the most extraordinary sights of the insect world. First comes a company of major workers, fearsome-looking creatures with huge heads and immense jaws. These are called "soldiers," but as a matter of fact all driver ants, large and small, are fierce fighters. Behind the advance guard comes rank after rank of minor workers with the baggage of the moving army. Some are carrying the dead insects or grubs which they have seized and borne

off from the ants' nests they have raided on the way; others have bits of stick, leaves, blades of grass, and all sorts of odds and ends that may come in handy on the march. A body of workers follows, bearing the precious babies, which they carry with them wherever they go.

On and on come the ants, swaggering along in close formation, in columns one or two inches wide and sometimes nearly a mile long. They pour like a cataract over every obstacle; nothing but fire or water will stop their progress. Every living creature flees before these terrible insect armies—monkeys, antelopes, even lions and elephants beat a hasty retreat when driver ants are on the warpath. For they would certainly be eaten alive by the angry insects if they didn't get out of the way.

Strange as it seems, these dreaded ants are mostly blind, or nearly so. But that does not seem to cause them any inconvenience. They communicate with one another by touch and in a very short time can telegraph news up and down the long marching columns in the most astounding way.

Antelopes are about the size of deer, and many, many thousands of times as large as an ant; yet they take to their swift legs with all possible speed when an army of driver ants bears down upon them.



Photo by Field Museum

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## Reading Unit No. 7

### THE QUEER WAYS OF THE LOWLY BEETLE

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How beetles fly, 3-329-30  
The work of good and bad beetles, 3-330-31  
Why scarab beetles are garbage collectors, 3-331-32  
Why some beetles bury dead animals, 3-332-34  
Ground beetles as hunters, 3-334-35

Why ladybird beetles are our friends, 3-335-36  
Beetles that use smoke screens and poison gas, 3-337-38  
Harmful beetles and weevils, 3-338-39  
Giant beetles, 3-340  
Glowworms and fireflies, 3-343

#### *Things to Think About*

How does the diet of a beetle affect us?  
Why do some beetles bury filth and dead animals?

Why does the ladybird beetle deserve our protection?  
What insects produce cold light?

#### *Picture Hunt*

What do dung beetles do with the ball they roll? 3-329  
Where are a beetle's flying wings located? 3-330

What insects are injurious? 3-331, 334, 339, 341, 343  
What insects produce light at night? 3-342

#### *Leisure-time Activities*

PROJECT NO. 1: Using a net and a jar containing a wad of cotton on which are a few drops of carbena or carbon tetrachloride, collect one beetle of every kind you meet. Watch them and study their habits before you try to catch them.  
PROJECT NO. 2: Visit a potato patch that has not been sprayed.

The yellow and black striped beetles and their pink grubs are potato beetles. What damage have they done? 4-361  
PROJECT NO. 3: Look for click beetles under dead bark during the winter. Thaw them out in your hand and place them on their backs, 3-338

#### *Summary Statement*

Beetles are insects with four wings—the upper two rounded and hard, the lower two gauzy and folded up when not used for flying. Beetles have biting jaws

and many ruin our crops. Farmers use poison sprays against them. Some beetles, like the ladybird beetle, eat many insect pests.

The Japanese beetle, shown here on a mallow bud and greatly enlarged, has become a scourge over the Eastern United States. It should be fought with vigor and determination.

Photograph from Edwin Way Teale



## ***The QUEER WAYS of the LOWLY BEETLE***

### ***Many of These Armored Insects Have Taken to Quaint Customs—and Not Always Nice Ones***

**I**N THE insect world the beetles are a little like the clowns. They are not so beautiful as butterflies nor so intelligent as ants and bees and wasps, but in their way they are interesting insects and some of them are highly amusing.

A solemn old tumblebug slowly plodding along the garden path, or lying feebly kicking on his broad back, does seem rather a dull fellow. But the beetles are not all so slow as a tumblebug, who, if he is so unlucky as to fall over on his back, is too awkward to turn himself right side up again. This position is not only undignified, but is extremely dangerous to the beetle. For if any of the tigerish little ground beetles or a party of wandering soldier ants find him in such a helpless state, they will set upon him, cut him up with their strong jaws, and devour him without the slightest twinge of conscience.

Standing on his six feet the clumsy old tumblebug is much better able to defend himself. His shoulders are protected by a broad shield, and the hind portion of his portly body is covered by a horny sheath—

too tough and slippery to be pierced by his bloodthirsty enemies. As a last resort, too, the beetle can always fly away; that is to say, he could fly if this way of escape should occur to his dull wits before he is overpowered by his enemies.

For with one or two exceptions the beetles can all fly if they choose. But as a rule they prefer to use their legs, and are more often seen running or crawling over the ground than sailing through the air. When we do meet a beetle on the wing, it is usually late in the evening. Most beetles dislike broad daylight and spend the sunny hours under stones, fallen leaves, or rubbish heaps; tucked away in cracks in walls and fences; hidden among the roots of plants, beneath the loose bark of trees, or in any other dark hole or corner they can squeeze into. In the cool of the evening they come out to feed, and then they sometimes fly around to visit their friends.

#### **Beetles Have Four Wings**

Beetles really have four wings, but these are so cleverly concealed when the insect

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is not using them that many people think they have none. The first two are hard and stiff, and fit together so perfectly when they are closed that the joint is visible only as a fine line down the middle of the back. These curious wings are usually called wing cases. Their chief use is to provide a protective covering for the "true wings" which are neatly folded up beneath them out of harm's way.

### How a Beetle Flies

The other two wings are as fine and transparent as those of a fly, and would very soon come to grief if they were not covered up when the beetle is running about or squeezing into a tight corner.

When about to set off on a flight, the beetle looks for all the world as if it were going to split itself in two! The crack down its back grows wider and wider until the wing cases stand out stiffly at right angles to its body. Then the gauzy wings are shaken out, and the next thing you know, the beetle has taken off from the ground and is soaring away, high over your head.

Although some beetles are quite at home in the air, many are but poor fliers. They cannot twist and turn about quickly when on the wing, so they are always bumping into things and crashing to the ground. But such accidents seldom seem to do them much harm.

### So Lazy They Lost Their Wings

Some beetles have given up traveling by air altogether. Although they have tough, horny wing cases over their backs, they have no true wings beneath them—or such small ones that they are quite useless for flight. The insects are then doomed to creep upon the ground all their lives. A few of them

have even lost the power of opening their wing cases, because they have had no need to open them for so long.

This state of affairs has arisen from the lazy habits of the beetles. Their ancestors in olden days had four good wings and flew about with the best of their kind. But as time went on, some of them used their wings less and less, and took more and more to creeping and crawling, until at last they lost the power of flight entirely.

### Mother Nature Crops Their Wings

For this is Mother Nature's way. If her children do not appreciate their blessings and make full use of their powers, they are not allowed to keep them.

There are enormous numbers of beetles scattered about the world. They seem to thrive in all climates and under all sorts of conditions. In hot countries, in cold countries, in the water as well as on the land, these hardy insects abound. Many are really splendid creatures clad in purple and scarlet, green and orange, or in glittering

suits of gold and silver. But others are dull enough in their plain brown or black coats.

There are beetles so small they can hardly be seen without a magnifying glass, and there are gigantic fellows with fearsome jaws and horns that may well strike terror to the hearts of all timid insect folk. Yet these alarming giants are usually quite mild, peaceful persons; their great horns are more ornamental than useful and are seldom employed as weapons.

### He Loves to Eat Red Pepper

So you see even beetles are not all alike. They vary greatly in their looks and habits. Many are terrible pests. They gnaw the



Photo by Cornelius Clarke

Our old friend the June bug is not a bug at all, but a sturdy beetle, who carries his delicate flying wings all folded up under his stout fore wings, unless he is actually in the air. Here he is shown getting ready to take off from the ground; the flying wings are partly unfolded, at each side of the wing cases.

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roots of growing crops, strip the foliage from the trees, tunnel into wooden beams and furniture, eat holes in our carpets and furs, get into the flour bins and spoil the flour, and do all manner of annoying things. There is hardly anything they will not eat. The dry-store beetles simply revel in red pepper, and thrive on poisonous drugs that would kill you or me if we ate them for breakfast, dinner, and tea as these queer little creatures

do. Some enjoy paraffin, and others think nothing so nice as a good cigar or a cigarette, or dried tobacco of any kind. Most of the damage they cause is done while the beetles are fat, worm-like grubs with hard, horny heads and jaws; but even when they have grown up, the behavior of some of them is quite shocking.

But there are good beetles as well as bad

ones. Some act as garbage men and do really useful work in clearing away all sorts of decaying rubbish that would poison the air if it were left lying on the ground. Some hasten the decay of fallen trees and old stumps in dense forests by riddling them through and through with tunnels. This helps to make room for fresh young growths to spring up. Others do us good service by hunting down and destroying the harmful insects that devour our crops and spoil our orchards and flower gardens by their greedy ways.

Chief among the garbage men are our old friends the tumblebugs and their close relatives, the small black or reddish beetles

so often seen flying about pasture land on warm autumn afternoons. These beetles belong to the great "scarab" (skär'áb) family, and their principal occupation in life is to scrape up all the filth they can find and bury it out of sight in the ground. I need hardly tell you that the beetles do not undertake this good work for the benefit of the world in general. They are simply engaged in collecting for themselves the food they like best, and in storing up supplies for their future offspring!

Most famous of them is the Egyptian scarab, or the "sacred beetle," as it is called, that lives in Southern Europe and in some parts of Africa. It

is an odd-looking insect, with very long hind legs and a funny flat head scalloped all around the edge and finished off with a pair of feelers that spread out at the tips like little red fans.

Hundreds of these queer little scarabs may be seen on sandy slopes in Southern Europe or on the edge of the Egyptian desert, all industriously pushing

and tugging and rolling mysterious round balls almost as big as themselves. Some are busy making the balls. They use their flat heads as shovels to scoop up the dirt and their stout bowed legs to twist and twirl the mass of stuff into a nice round lump.

Others are laboriously trundling their property uphill, walking slowly backward and pushing the ball behind them with their long hind legs. Every now and again one of the beetles will pause for a moment and look around to see if the way is clear. As likely as not, in doing so he lets his ball slip from his clutches. Then away it goes merrily bounding down the slope, with the poor old scarab ambling after it as fast as



Photo by Cornelia Clarke

The grooves in this pine wood were not carved with a jack-knife, but were eaten out by the grub of the pine beetle. The eggs are laid in the grooves, between the bark and the wood, and when the youngsters hatch they start eating and eventually kill the tree by girdling it.

The harmless-looking creatures below are known as carpet beetles. Their name reveals their infamous character.



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his odd legs will carry him. If he manages to head it off, he will start trundling it back again with the greatest patience.

### A Queer Place for a Nursery

When the beetle succeeds in rolling his ball home to the hole in the ground already prepared for it, he will sit down and munch away until the last scrap of the feast is finished. Sometimes his mate joins in the banquet, after having first helped to provide and push home the fare. But the female has frequently a less selfish end in view when she makes and rolls a ball of her own. Right in the center, in the softest part, she places one of her eggs. Then, having buried the ball, she leaves it to supply plenty of food for the young beetle grub who will be born in due time.

Strangely enough, it was the thoughtful care of the female

beetle that first gave the little scarab its title of "sacred beetle." The old Egyptian priests who dwelt by the waters of the Nile saw the beetles rolling their balls, and also they sometimes saw young beetles breaking their way out; but they did not know anything about the eggs so cunningly hidden inside by the female scarab. So they jumped to the conclusion that the beetles actually created others of their kind out of the dust of the earth, and so they ordered the Egyptians to treat the little scarab with all honor as a sacred creature.

The burying beetles—or sextons, as they are sometimes called—are another family of interesting and useful insects. But instead of helping to keep clean the paths and pastures of the countryside, as the scarabs do, they seek out and decently bury little wood-

land beasties that have come to an untimely end. They are handsome, sturdy insects with strong, flat heads, club-shaped antennae, and shiny black wing cases marked with two broad wavy bands of deep red or orange. They hunt in couples. Soon after the sun has set, the male and female start off in search of any small furred or feathered creature that lies unburied on the ground.

If a little field mouse has been killed and left by its slayer—who may have been frightened away before he could devour his prey—

the burying beetles scent it from afar and come flying to the spot in the twilight. Two or three couples may come hurrying up to help in the task of burying the little corpse, and all set to work without delay to dig a trench around it. Using their hard heads as spades they shovel up the earth and throw it out of the trench; they

then burrow underneath the mouse, carrying load after load of soil on their heads, until gradually the tiny body sinks lower and lower in the ground. Finally the beetles crawl out of the hole and, after carefully raking the earth over the mouse and smoothing it with their feet, they open their wing cases, unfurl their gauzy wings, and fly off.

### Born in a Grave

But why do the beetles do this strange thing? It cannot be simply because they are hungry, for they could quite well make a meal of the mouse without going to all the trouble of burying it first. If we carefully watch the gravediggers we shall see that they do not all crawl out of the grave before it is covered over. When their task is done the male beetles fly off, but the fe-



Photo by F. Martin Duncan

This is the fellow one sees beautifully represented in carvings for rings and necklaces and pins. He is the scarab, or sacred beetle, of the Egyptians, and for centuries received most reverent worship. Now we laugh at him for his funny antics.



## WONDERS OF THE INSECT WORLD



All but one of these armored air cruisers is a beetle. Some you may find at your own doorstep. Others come from distant India. But whether they live in the water or in the air, on grapevine leaves or filthy refuse, they all belong to the beetle tribe. And their neat arrangements of shell and claw always help them to be happy and prosperous. Think how easily the water beetle at the center right could slip through the water. Below him is a true bug.

Photos by F. Martin Duncan and Cornelia Clarke

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The little circle shows the green tiger beetle, or sparkler, a lively little thing dressed in a beautiful golden-green suit that shines as if it were made of metal. The tiger beetle is well named, for it is powerfully armed with strong, toothed jaws and can destroy its prey quickly and fearlessly. On the leaf is a gathering of striped cucumber beetles about to do their worst. They are about the size and shape of a ladybird, and are a pale yellow with black stripes.

In France and Germany one of the tiger beetles is most useful, for it feeds on caterpillars that do great damage to the oaks.

males are left behind buried with the corpse. There, hidden in the ground, the mother beetles proceed to lay clusters of tiny eggs; and not until this duty is finished do they push their way up through the loose soil and fly off to join their mates. So you see the beetles take all this trouble in order to provide plenty of food for their young ones.

### Bold Determined Hunters

The ground beetles, which are very numerous, work in a different way. They are bold, determined hunters, always on the warpath, chasing and killing insects and other small creatures with relentless fury. They attack cut-worms, cankerworms, hairy tent caterpillars, and all sorts of harmful insects; so they are a great help to the gardeners and do a great deal of good without intending it. Even as grubs these beetles are useful, for they burrow just below

the ground and feed on insects that destroy the roots of crops.

Photo by Cornelia Clarke

Ground beetles are called by all sorts of names. The "searcher" is a fine fellow an inch and a half long with bright green wing cases shot with violet and bordered with red. The "hunter" is black ornamented with light copper-colored dots. Some are quite tiny things, but they are just as fierce as their bigger cousins. All are distinguished by their flat, smooth bodies, small heads, and the shapely, pointed jaws with which they nip you at once if you interfere with them when they are hunting. Some of the bold hunters fly about very actively. Others have no true wings under their wing cases, but to make up for the handicap they all have very long legs and can run very fast. One unusually strange ground beetle is the fiddler beetle that lives in Malaya. It looks quite like a violin.

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The ground beetles, like so many flesh-eating creatures, seldom start hunting till dark; but the tiger beetle, which is every bit as fierce and bloodthirsty, is out in the full light of day, scouring the country for prey. On hot sunny mornings you may find him dashing about on sandy plains or dusty roads, a smart little fellow with a slim, trim, brightly colored body—usually some shade of green—with contrasting spots of copper or yellow.



Photos by Cornelia Clarke

The tiger beetle is surprisingly quick both on the wing and on foot—as you will soon find out if you try to catch him. He tears about on his long, thin legs, zigzagging over the ground, and just when you think you have him he whisks round in a flash and is speeding away in the opposite direction for all he is worth!

### A Born Villain

With his sharp jaws and his strong suit of armor the tiger beetle fears no foe. He will boldly attack creatures much larger than himself and hang to his prey like a bulldog if you attempt to rob him of his prize.

This quarrelsome little insect is just as tigerish in its youthful days, though as yet unable to career about in search of its dinner. Its short, spiny legs are quite useless for running, and its long soft body has no armor to protect it against its natural foes. The young tiger beetle is really a very ugly little grub. It has a hump on its back, a large, flat, horny head, and a terrible pair of huge, sickle-shaped jaws. On the top of its hump are two small curved hooks, and its sides are

adorned with little tufts of stiff bristles.

Now the tiger grub is a hungry little grub, and it cannot live without eating; so since it cannot go “a-hunting,” it needs must find some other way of getting food. Using its flat head and spiny feet as tools, the cunning little creature digs out a vertical tunnel, two or three inches deep, in the sandy soil. Then it rests at the top, clinging to the sides of the shaft with its hooks and spines and blocking the entrance with its big head.

There the little tiger grub lies in wait. Sooner or later some unwary insect is sure to pass within reach of those terrible jaws. Then up with a jerk comes the ugly head and the insect is dragged down for a dinner for the wily little ogre.

You would hardly imagine that such tiny things as ladybirds could be of much importance. Yet these pretty little spotted



No one needs to be introduced to our great friend the ladybird, though most of us would hardly recognize her when she is a larva, as in the circle, or a pupa, as in the square. We know her as a bright little spotted creature who saves our fruit growers and gardeners thousands of dollars a year by eating the destructive plant lice.



beetles are very useful friends to the farmer and gardener, for they wage constant war against the mischievous little plant lice and scale insects that do so much harm in our fields and gardens.

The ladybirds creep quietly over the plants infested by such troublesome insects and pop clusters of tiny eggs here and there on the foliage. Now and then they refresh themselves by eating a few plant lice, but the ladybird has no great appetite, and it would take a few thousands of the bright little beetles to do much harm to the swarms of lice that crowd in untold numbers on the green leaves and young shoots.

### How Ladybirds Kill Plant Lice

But when the wee beetle grubs hatch out from their yellow eggs, they are desperately hungry. They are brisk, energetic little creatures. They run about very fast clutching the little lice and cramming them

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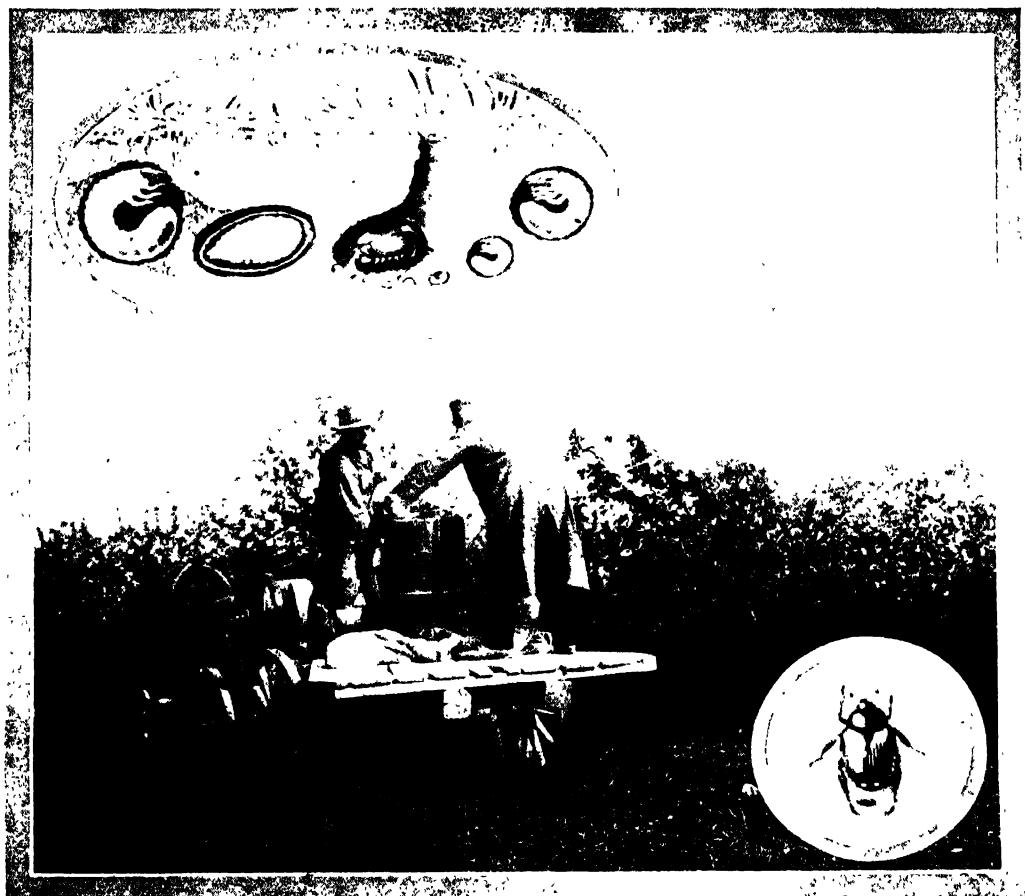


Photo by U. S. Dept. of Agriculture

Here is another pest that is as bad from the grower's point of view as any plant disease. It is the Japanese beetle, shown in natural size in the circle; it was discovered in the Eastern United States in 1916. This beetle lays its eggs in the ground—in a fine, well-groomed lawn if one is handy! There the young go through various stages of growth, as illustrated in the oval. Then the beetle climbs out and flies off to the

nearest plant or tree, where it proceeds to eat up the leaves. When a troop of Japanese beetles get through with a tree its leaves are mere skeletons, as full of holes as a sieve. And of course if a tree loses too many of its leaves it will die, or at least cease to be either beautiful or useful. By improved methods of spraying, as shown in the main picture, this pest can be kept in check.

into their mouths with their two front legs. It would be hard to say how many of the little pests a ladybird grub will account for in the four or five weeks of its active life.

As is usual in the insect world, these beetle grubs are not at all like their parents. They have long, rather flat bodies tapering to a point behind, rough dark skins spotted with red or yellow, and little tufts of bristles down each side. When the time of rest approaches, the little creature does not hide in the ground as most beetle grubs do, but fastens itself by the tail to a leaf or twig, like the caterpillar of a butterfly. Then it shrinks, and, in place of the brisk little grub, behold! a hard, round

button of a thing brightly colored and covered with spots! Even now it does not remain perfectly still all the time. If touched, the funny little pupa springs up with a jerk and stands on its tail in a semi-erect position. This trick no doubt scares away many a creature who might be inclined to eat it up.

A ladybird is really a beetle, although it does not look much like one. Under its painted wing cases two delicate transparent wings are folded away; so it can fly very well, besides being nimble on its feet. Birds do not like these little insects, for they have a most unpleasant smell and a very bitter taste; so birds leave them alone.

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Beetles are just as cunning as other insects in the tricks they use to deceive their enemies. Some beetles "play 'possum," pretending to be dead at the first alarm; others, like the furry little pill bug, tuck in their heads and their legs and roll themselves up into hard, slippery balls directly they are touched. Bad-tasting beetles, if they are not decked out in the warning color of red and yellow, often advertise the fact of their unpleasantness by a very disagreeable smell. Others try to bluff their enemies by pretending to be dangerous creatures, when really they are nothing of the sort. And certain beetles have more than one trick in reserve to startle their foes and save their own lives.

The rove beetle - - sometimes called the "devil's coach horse" or the "cocktail"—is one of these accomplished insects. He is an odd creature with a long black body that he can turn and twist about as he pleases, for his wing cases come only a little way below his waist, like a short jacket, and do not cover the whole of his back in the usual beetle fashion. Nevertheless, under those wing cases the rove beetle has a fine, broad pair of flying wings folded away.

If you meet a rove beetle taking a quiet stroll down a country lane, he looks mild and innocent enough; but try to stop his progress by thrusting a stick or a grass stalk in his way, and in a moment he is transformed into a furious little demon! Up goes his head with an angry jerk. He cocks his tail right over his back, brandishing it in a threatening manner as if he were going

to strike like a scorpion. If this does not scare you away, he brings his second trick into action and squirts you with an evil-smelling spray from two little scent tubes in the tip of his tail.

Now the rove beetle has no sting; and although the scent he squirts is very nasty, it is not poisonous and does no harm. The behavior of the bold little creature is sheer bravado. But many a time it has the effect

of scaring away his foes.

The "devil's coach horse" has a number of smaller relatives that all act in the same impudent way. Many have bright colors among their attractions, and some are such tiny things they are often called "black flies." In the Far West swarms of wee rove beetles dance like gnats in the air on warm spring evenings. They get into your eyes and

make them smart, and are really a great nuisance.

### The Beetle with a Smoke Screen

The funny little European bombardier (bom'bär-dēr') beetles have even more surprising ways, for they actually use poison gas as a means of defense. Small armies of them roam about the countryside and, if attacked by a more powerful insect, the whole company turn their backs on the foe and discharge a volley of explosive gas bombs full in his face. Then, before the astonished and half blinded enemy can recover himself, the bold bombardiers beat a hasty retreat under cover of the clouds of irritating smoke they have produced.

The gas the beetles use is stored, in a

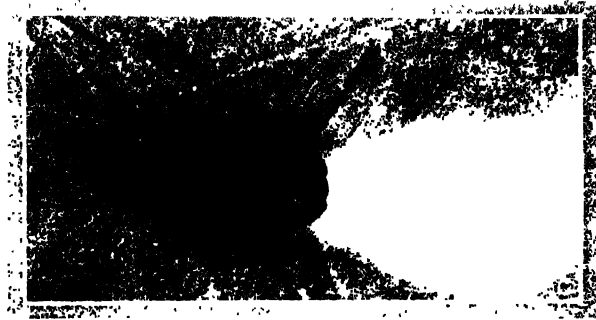


Photo by Cornelia Clarke

Here is one of the funniest little fellows of all the beetle tribe. It is the insect sharpshooter known as the bombardier beetle. Our photographer has caught him clad in his customary uniform of blue and sitting on an oak leaf. He is blazing away with his little popgun, which he sets off with a sharp report whenever he is disturbed. Then follows a cloud of smoke which is as bad as poison gas to any insect foe. He would seem to carry only three rounds of ammunition on any given day, for no provocation can induce him to waste his powder further. But after a night's rest his gun is loaded again. If you suddenly lift a stone or old log as you walk through the damp woods, you may have the luck to see a bombardier beetle scurrying away, with a pop-pop-puff of his artillery to cover his retreat. If you catch him and hold him between your thumb and finger, you will find that he grows quite hot—with indignation, of course!

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liquid state, in a special gland at the tail end of the insect. When it comes into contact with the air the liquid evaporates and makes little puffs of stinging white smoke.

There are certainly a great many more destructive beetles than useful ones. There are hosts of them doing all they can to destroy timber, grain, fruit, vegetables, and crops of every kind all over the world. In North America the dreaded Colorado beetle—or the potato bug, as it is called—sometimes destroys whole fields of potatoes.

### **The Unpopular Potato "Bug"**

The female Colorado, a sturdy-looking black and yellow insect, may deposit a thousand eggs or more on the plants in a single season, and the humpbacked potato grubs, with their red bodies and black heads, swarm all over the vines and munch away at the leaves. Their greedy ways may cost the potato growers thousands of dollars.

### **The Skipjack Is an Acrobat**

The queer little click beetle, or skipjack, is another troublesome offender, although its antics are most entertaining. It is a genuine little acrobat, constantly amusing itself by turning somersaults in the air. If, as it runs about the fields and climbs up and down the grass stalks, the skipjack chances to fall over on its back, the accident does not worry it a bit. Instead of lying feebly kicking its legs, as the tumblebug does, it arches its body so that only its head and the tip of its tail touch the ground. Then with a sudden click the little acrobat jerks itself up in the air, turns a complete somersault, and comes down on its feet, right side up again. It does this trick by means of a kind of notch and catch on the under side of its body. By bending itself backward it releases the catch, strikes the ground with a sudden jerk, and rebounds into the air.

### **A Living Piece of Wire**

It is while they are grubs that the click beetles do so much harm. They live for two or three years buried in the ground, wriggling their way through the soil and

munching the roots of all sorts of useful plants. Whole fields of grain are often ruined by the troublesome little things, which are called "wireworms" because they look more like short pieces of thick, rusty wire than like anything else.

The leaf chafers are quite as bad in their ways as the click beetles. They are handsome insects as a rule, and they are all distinguished by their feelers, which have a number of little leaflets at the tips that can be opened or shut like a fan. The male chafers have the finest feelers. The female always has a much smaller fan than her mate.

### **Greedy Grubs**

The pretty rose chafers, with their golden-green wing cases, love to feed on roses and the flowers and foliage of the grapevines. Before they develop into perfect insects they live in the ground and gnaw the roots of grasses and other useful plants. Their big, handsome cousins the May bugs and the June bugs, which come whizzing through the air on warm evenings, are even worse offenders. They devour the young green leaves and shoots of trees, often stripping the branches nearly bare; and their ugly white grubs gnaw the roots of grasses and food crops for two or three years before they change to beetles. The young chafers eat so much and grow so fat that they cannot stand up on their six little legs; so the greedy grubs are always obliged to lie curled up on one side. In this odd position they wriggle through the ground, biting at the roots as they go.

### **The Evil Weevil**

May bugs, or cockchafers, are just as troublesome in Europe as in America. In France they sometimes do so much damage that rewards are offered for their destruction.

Then there are the weevils, or snout bugs—there is simply no end to the damage these can do. They are mostly tiny things, many so small that you can hardly see them; but that makes no difference in their evil ways. These little beetles—and there are thousands of them, each as bad as all the

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others—may be known by the peculiar shape of the head, which is so drawn out that it looks like a long nose. This nose or beak is the female weevil's boring tool. With its aid she pierces the fruit or nut or young bud she thinks her children will most enjoy, and in each tiny hole she pops

they were dead, hoping to pass unnoticed until the danger is over. Then up they crawl again and continue their thievery.

One of the worst of these little pests is the boll weevil, which deposits its eggs in the buds and pods of the cotton plants, sometimes destroying the entire crop.

Giant beetles are not nearly so overwhelming in their numbers as the wee mischievous imps that swarm over all growing things and give so much trouble. And this is just as well, for if the giant stag beetle, for ex-



Photos by Nat Magazine and Cornelia Clarke

Who would ever suppose that this pudgy worm was going to be a hard-shelled June bug and go bumping about the street lights on summer evenings? Here it is underground, where it grows so fat on roots that its six short legs can't carry it.

an egg. The young weevil grubs, when they hatch, have a very good time; but the fruit they have been feeding on is spoiled and useless, and the nuts from which the weevils have escaped are full of a disgusting pulpy mass instead of sweet kernels.

### The Weevil That Kills the Cotton

While the weevil grubs are working away inside the fruit and buds, the full-grown beetles attack the leaves and shoots and flowers and even the tender green bark. But although they may be swarming in thousands over the trees and bushes, the little culprits are not at all easy to see at their tricks. For besides being so tiny, they are mostly so quietly dressed in brown or gray or dull green that they are practically invisible as they creep about. They are very cunning, too. If you shake the tree they fold up their legs and fall plump to the ground, and there they will lie as if

If the creature above were not so safe on the printed page, we certainly would never let him live. For he is the hated "potato bug," the Colorado beetle. This terrible pest has done so much damage to the



potato crop in America that every European country has passed strict laws to prevent his immigrating.

ample, crowded the trees as the weevils do, the branches would break down under the weight of the heavy insects. The giant stag beetle of the southern states is often two inches long, and the common pinching bug of the East is only half an inch shorter.

### Young Stags Thrive on Rotting Wood

These beetles look very fierce and alarming as they move along in their dignified way. Their great jaws, shaped like the antlers of a stag, are slightly raised as if ready to attack all comers. To be sure, if you interfere with one of the big fellows you may get a sharp nip for your pains, but they are really very peaceful creatures. Stag beetles do not hunt and kill other insects.

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They love sweet food and live chiefly on the sap that flows from bruised places in the trees and on the honeydew formed by plant lice and scale insects. Their big white grubs live in decayed trees; they thrive and grow fat on the rotting wood, and do not become perfect beetles for several years. The stag beetle's gigantic jaws are no doubt useful in keeping enemies at a respectful distance, as few creatures would be bold enough to challenge such a well-armed warrior to combat.

Male stag beetles sometimes fight among themselves to gain the favor of a lady stag. Then a tremendous gnashing and clashing of jaws takes place, but the rivals seldom appear to damage one another seriously.

Still bigger than the stag is the curious rhinoceros beetle that has gained its name from the stout, curved horn projecting from its shoulder shield. It measures some two

and a half inches in length and is the largest North American beetle. Its cousin, the elephant beetle of South America, is five inches long and carries a long, curved horn—absurdly like an elephant's trunk—on the point of its head. But the great Hercules beats both the rhinoceros and the elephant beetles. It is no less than six inches long and boasts two enormous horns—one projecting forward from its shoulders, the other rising from the top of its head and curving upward. Together they form an awe-inspiring pair of pincers.

### Giant "Bugs" Six Inches Long

The giant Goliath is an African beetle. He is four or five inches long, and as stout and portly as a toad; his shoulders are velvety black strikingly decorated with stripes and splashes of white or yellow, and the wing cases are a deep chocolate brown.

Although such a big fellow, the Goliath is not so terrifying in appearance as many of the giants of his race. He has only two funny little blunt horns on his head, though he wears sharp spurs on his legs and hooked claws on his feet.

### "It Doth Grunt Aloud Like a Pig"

These great beetles are not often seen. They live in the dense African jungles, fluttering heavily around the tree tops and feeding on the flowers and juices of the climbing plants. There are also smaller Goliath beetles that are really beautiful insects, with pretty green wing cases marked with snowy white.

But the giant longhorns of South America are the most gigantic beetles in the world. One member of this distinguished family is said to be nine inches long, and thick and broad in proportion. The long horns are really

the beetles' feelers, which in some cases are two or three times as long as the insects themselves. Some of these beasts are called "sawyer beetles" because they have very strong toothed jaws which they use to saw through the bark on the branches of forest trees in order to reach the sap.

In a very old natural history book a writer gives us a very funny picture of one of the huge sawyer beetles. This is how he describes it:—"It hath a little broad head, great ox-eyes, almost three fingers overthwart in length; it hath a forked mouth, gaping and terrible, with two very hard crooked teeth: with these, while he gnaws the wood (I speak by experience), it doth perfectly grunt aloud like a young pig."

In the struggle for life that is always going on in the insect world, the numerous beetle tribes are well equipped to hold their own. Strong wings and swift feet make



Photo by Cornelia Clarke

Here is the male of the stag beetle. Be careful to keep your fingers away from those stout pincers!



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How different they are—and yet they all are beetles! There are so many members of the tribe that it includes about half of all living insects.

You might well look for cover if you saw this great dragon coming toward you full tilt. It is the male Hercules beetle, six inches long and provided with a pair of pincers that could give one a terrible nip. It lives in Brazil, and is one of the largest of all insects. Here it is shown with its wing cases raised and its flying wings outspread.

The cherry curculio, below at the left, is a wretched little beetle that makes a cut in young cherries when they are about the size of a pea and leaves an egg in the fruit.

You don't need the picture at the right to tell you what happens.

The demon at the right is the boll weevil, a beetle that has caused the loss of millions of dollars to cotton growers. One pair may have nearly 13,000,000 children in a season, enough to devour a whole crop. In reality the boll weevil is very small, but its size here is quite in proportion to the harm it does.



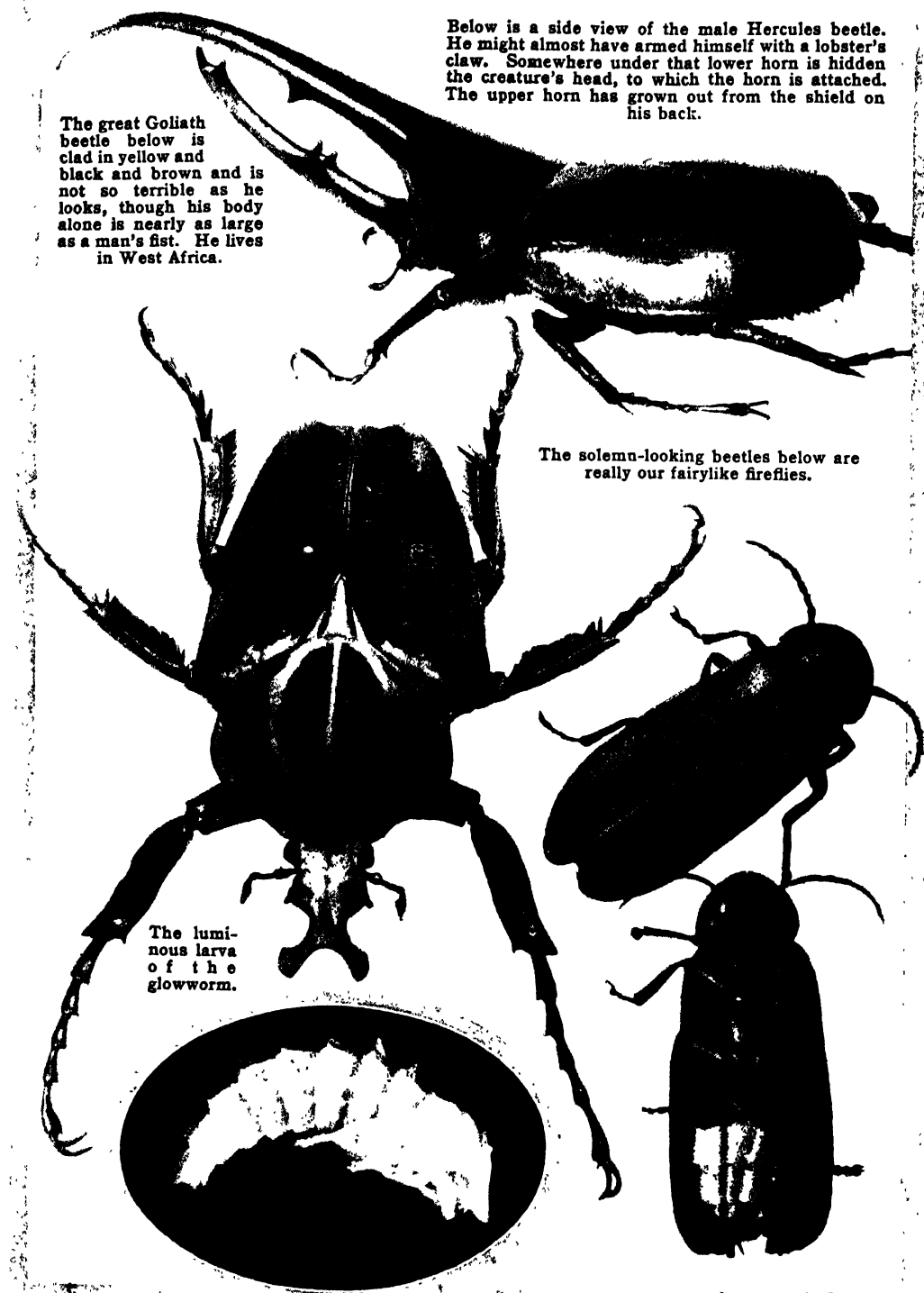
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The great Goliath beetle below is clad in yellow and black and brown and is not so terrible as he looks, though his body alone is nearly as large as a man's fist. He lives in West Africa.

Below is a side view of the male Hercules beetle. He might almost have armed himself with a lobster's claw. Somewhere under that lower horn is hidden the creature's head, to which the horn is attached. The upper horn has grown out from the shield on his back.

The solemn-looking beetles below are really our fairylike fireflies.

The luminous larva of the glowworm.

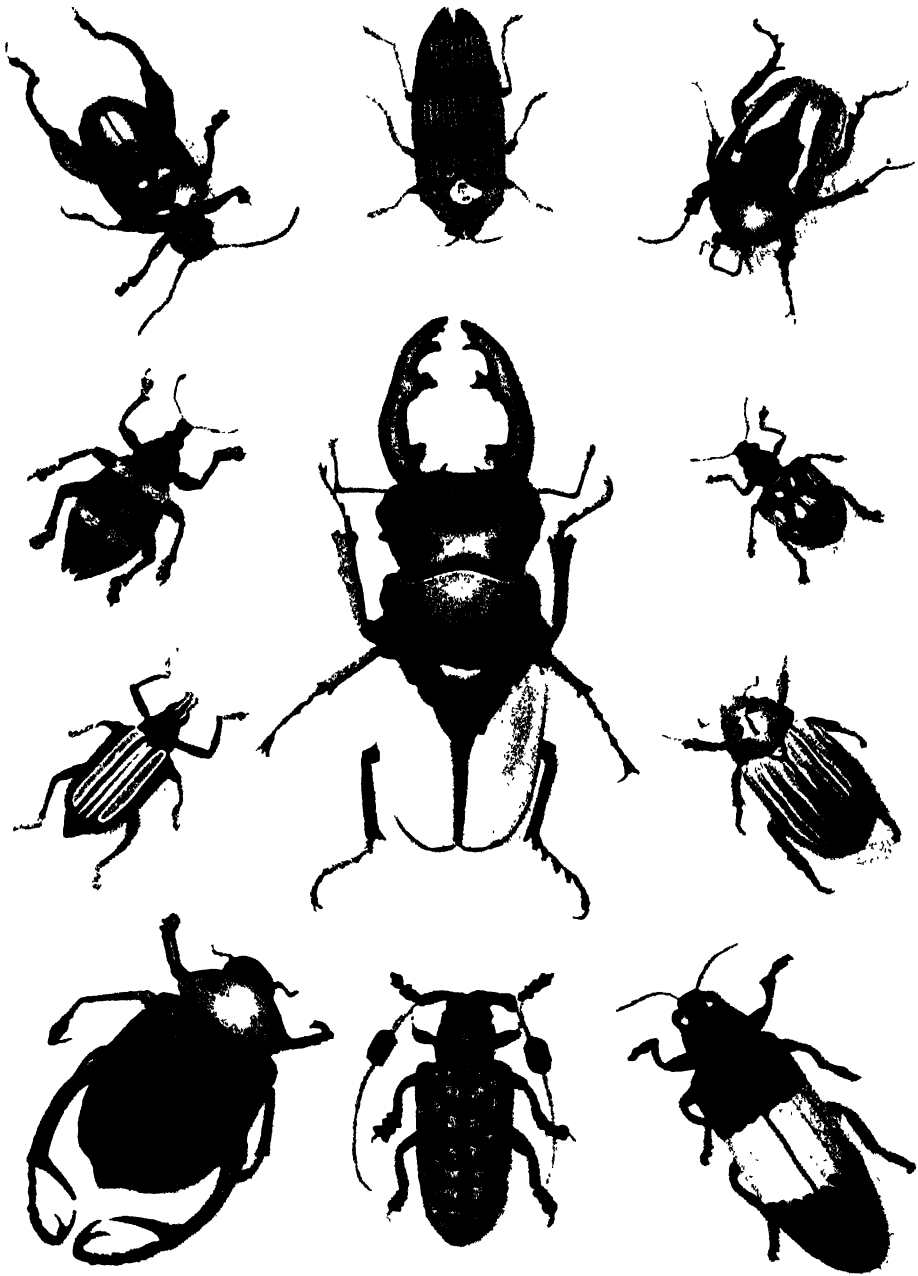


Photos by Cornelia Clarke and F. Martin Duncan

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*When next you meet one of these animated jewels on the garden path, don't say to yourself, "Just another bug," and hurry on by. For in the first place, he may not be a bug at all, but a beetle—and every*

*wide-awake person should know the difference between the two. And in the second place, he may not be "just another" one, he may be new to you. Give him at least a second glance.*



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many of them equally at home in the air and on the land. They have armor-plated suits to protect them; useful tools and weapons to serve them on all occasions. Beetles knew how to dig and fight long before we did. The lowly little creatures even forestalled us in the use of artificial illumination. Ages before man first discovered how to make a light, certain little beetles were already in the habit of lighting up their tiny lamps as soon as daylight failed.

In England and in the south of Europe, on soft summer nights, glowing sparks shine out here and there under the hedgerows, like tiny fairy lights. If you touch one it disappears, as if the fairy of the lamp had switched off her light. Nothing is then to be seen but a queer little beetle called a "glowworm." She is certainly no beauty, for although she is a full-grown beetle, she has no wings or wing cases, and looks much as she did when she was merely a beetle grub. Like Peter Pan she has never grown up! But no matter. Each summer night she lights her lamp and waits patiently for visitors to come and cheer her; and guided by her beacon, the little male glowworms, who have wings, come flying from far and near to pay their court to the "lady of the lamp."

Most wonderful of "living night lights" are the fireflies of South America and the West Indies. Although they are called flies, the luminous insects are really beetles,

closely related to the furry skipjacks. On hot sultry nights the dark forests are ablaze with the flashing green lights of thousands of the little insects as they joyously dance and chase one another in the air.

There are fireflies, too, in North America and in the Far East, while in Southern Europe thousands of small luminous beetles sparkle like diamonds as they cluster on the dark trees and bushes on hot nights, or flash like shooting stars through the air.

Though beetles seem humble enough to us, they are among Mother Nature's favorite children. She



When you find an apple tree full of holes about the size of a pencil, you may know that the apple tree borer has been at work. It is a stylish-looking brown and white insect that lays its eggs in a hole it makes in the bark of an apple tree. The egg hatches into a yellow grub, which begins at once to tunnel into the tree and eats its way along for two years, sometimes going quite through the trunk. Just before it is time for it to turn into a pupa, it tunnels to the surface, plugs up the opening with sawdust, and goes to sleep in its snug chamber. When it awakes, it crawls out into the world a full-grown beetle like its mother. No cure is known for this pest, which kills many an apple tree.

has done so well by them that they can live everywhere, on any-

thing, and thrive. It is this marvelous power to survive that one author comically describes:

"When the Moon shall have faded from the sky and the Sun shall shine at noonday a dull cherry red; and the seas shall be frozen over, and the ice-cap shall have crept downward to the Equator from either Pole, and no keel shall cut the water, nor wheels turn in mills; when all cities shall long have been dead and crumbled into dust, and all life shall be on the very last verge of extinction; . . . then, on a bit of lichen, . . . shall be seated a tiny insect, preening its antennae in the glow of the worn-out Sun, representing the sole survival of animal life on the Earth—a melancholy bug."

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## Reading Unit No. 8

### INSECT FIDDLERS AND MASQUERADERS

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How the locust makes his music, 3-345-47

How baby grasshoppers resemble their parents, 3-348

Crickets and mole crickets, 3-348-49

The cannibalistic mantis, 3 350-51

Leaf insects that are invisible, 3 352

Insects that look like sticks, 3-352

Roaches and earwigs, 3 355

#### *Things to Think About*

What part of its body enables an insect to "sing"?

How does the mantis catch its prey?

How may insects be invisible even when you look at them?

Why are roaches disliked?

#### *Picture Hunt*

Where is a cricket's ear located? 3 346

How does a baby grasshopper grow? 3-347-48

Why are katydids often hard to find? 3-350

What insect holds its legs as if in prayer? 3-355

#### *Related Material*

What insects carry the germs of disease? 3-360-65

What experience with insects almost wiped out a young com-

munity? 3-367-68

What insects are called incorrectly "locusts"? 3 371

#### *Leisure-time Activities*

PROJECT NO. 1: Capture a praying mantis, put it in a large jar, and feed it a live grasshopper. Watch what the mantis does. 3-350-51

PROJECT NO. 2: Capture a few young grasshoppers. Place them in a covered glass jar and

feed them fresh grass daily. See how they moult, and preserve the empty case for display. 3-347-48

PROJECT NO. 3: Capture a large grasshopper and study its flying wings, and its ears which are found behind the base of the hind legs.

#### *Summary Statement*

Grasshoppers, locusts, katydids, mantids, crickets, roaches, earwigs, stick insects, and leaf insects are all related. They all resemble their parents when they

are hatched, though just at first they lack wings. They cast off their old shells as they grow larger.



Our model shows the interesting little mole cricket greatly enlarged. It lives along the edges of ponds and ditches, where it digs winding burrows, as the mole

does, and lives on roots, earthworms, and larvae. Those strange paddlelike affairs behind and below its eye are really its foreleg adapted to digging.

## INSECT FIDDLERS AND MASQUERADERS

### *Small Musicians That Make Merry All Day Long and Insects That Dress to Look Like Leaves or Sticks*

**I**NSECTS may be small folk but they often make a surprisingly big noise in their own little world.

All through the hot days of summer and early autumn, we hear them cheerily humming and buzzing, chirping and drumming up and down the countryside. Bees, flies, and beetles all help to swell the merry chorus of busy little creatures rejoicing in the warmth and brightness of the sunny hours. Loud above them all rings the shrill chirping of the locusts, grasshoppers, crickets, and katydids, for these long-legged, acrobatic insects are the most famous musicians of the insect world.

All through the day, and through the nights as well, the lusty fiddlers keep the concert going. In the fields and meadows the grasshoppers trill; along the dusty lanes the locusts shrill and "clack"; and in wood, garden, and orchard, crickets chirp and katydids repeat over and over again, "Katy-did, she-did-she-did, Katy-did-she-didn't!"

Now, although it seems a strange thing to say, all these noisy insects are really dumb. They do not "sing," for no insect is able to make sounds in its mouth or throat. Locusts, grasshoppers, and their nearest relatives are not choristers but orchestral performers, and their musical instruments are their long hind legs and their stiff wing cases. Crickets, green meadow grasshoppers, and katydids perform by raising their wing cases and rubbing them briskly together. One wing case has a sharp edge, while the other is like a file; and with this arrangement the little musicians are able to produce a shrill, chirping note.

The locust has a more complex instrument of music. On the broad, flat thigh of his long hind leg he has a row of small knobs, like a row of beads. When he is in a mood for a little music, he draws his leg rapidly backward and forward across the rough edge of his wing case, just as if

## WONDERS OF THE INSECT WORLD



Photo by American Museum of Natural History

How long do you suppose it would take you to guess that the spot the arrow is pointing to, on this greatly enlarged cricket's leg, is really the insect's ear?

he were playing on a fiddle. Only the male insects are gifted in this way. The females have no musical instruments. But they seem greatly to admire the chirping of their mates, who never tire of showing off to attract their attention.

Musical insects have more than one accomplishment. They are the champion long jumpers of the insect world. If we could leap as far, in proportion to our size, as some of the locusts and grasshoppers, we should need no automobiles or airplanes to take us about the country. In a few hops we could cover the ground as quickly as Hop-o'-My-Thumb in his seven-league boots, and be able to bound over trees and buildings with the greatest ease!

All chirping and leaping insects have wonderful flying wings. They are semicircular in shape, and open and close like a fan. When not in use they lie neatly folded in long, straight pleats under the protecting fore wings, which are much less delicate in texture. Many of the flying wings are most beautifully colored and marked in all sorts of startling ways. But the fore wings are less remarkable. They are usually of some shade of green or brown which tones so well with the color of the soil or foliage on which the insects rest that it is

by no means easy to see the cunning little creatures until they betray themselves by taking a sudden flying leap into the air. Even their shrill chirping does not always give them away, for a cricket or a grasshopper is a clever ventriloquist. He can throw his 'voice' in all sorts of directions, and it is often quite a puzzle to tell exactly where the sound is coming from.

The common American locust is a fine fellow, fully three inches long from head to tail, with a reddish-brown body, marked with a yellow stripe all along its back, and clear, transparent hind wings. It is sometimes very troublesome in devouring the crops, but it is not nearly so bad as its terrible cousin, the "migrating locust," whose destructive ways we shall learn presently.

The Carolina locust is another species common all over the United States and Canada. It is nearly two inches long, pale yellowish or reddish brown in color, and has handsome black flying wings

Here is the green locust. Can you make out his music box, which he always carries about on his back and loves to play on warm summer afternoons? To create its far-reaching sounds he lifts one wing just a trifle and vibrates it rapidly against the other.



Photo by Cornelia Clarke



## WONDERS OF THE INSECT WORLD

with a broad yellow border ornamented with clusters of dusky spots. This locust is fond of hovering in the air a few feet above the ground and making a loud "clacking" noise by scraping the edges of its wing cases across

odd, sharply pointed little face. Other tiny locusts, less than half an inch long, hop and skip about in swampy meadows and around ponds and streams, where their wee dark bodies are practically invisible on the muddy ground.

### The Locust Beau Brummel

The most gorgeous as well as the most extraordinary locusts are to be found living in hot countries. Even the tropical butterflies are rivaled by a big South American locust whose body is decked out in light green splashed with black. His wing cases

Photos by Cornelia Clarke



the stiff edges of the hind wings

The coral-winged locust, or "king grasshopper," as it is often called,

He has a knowing look, this grasshopper who is our well-known friend of lawn and field.

makes a loud, rattling sound with its wings as it flies. It is quite common in the Mississippi Valley, and is a very fine insect indeed, with its bright coral-red wings that gleam splendidly when the light shines through them in flight.

Other handsome locusts have clear yellow wings, or red and yellow wings with black or dusky marks and borders. But there are a host of dull little locusts all up and down the country who are not so fond of flying and leaping as their more gaily colored cousins. "Safety first" is their motto. So they hide themselves as much as possible and are never known to show off.

The short-winged yellow locust of the eastern states is more often heard than seen. It spends most of its time tumbling and dodging about among tall grasses, where its natural enemies, the birds, cannot easily distinguish its tiny dull-colored body and



Insects, like children, outgrow their clothes. The grasshopper has five different suits in the course of a lifetime. Here are the four that one of them has had to shed.

are pink laced with black, and his flying wings are a blazing scarlet with black borders. As he hurls himself through the air he must look much like a flower that

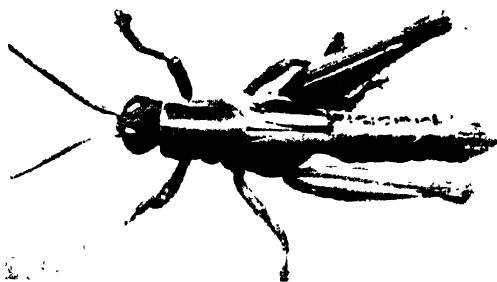
has taken leave of its stem.

Some of the South African locusts wear a kind of spiked helmet, all covered with spines and prickles; and the head of a tiny Indian species is covered by a huge peaked cap. Strangest of all, perhaps, is a large South African locust that looks exactly as if she were made up for a fancy-dress ball. We say "she" because it is the lady locust who is dressed in this way; her mate is more modestly attired in plain green. The general coloring of the strange insect is a bright apple green, relieved with silvery-white stripes and splashes edged with bright magenta. She has magenta patches on her face, as well as a large number of small

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white lumps, like tiny pearl beads, each encircled by a mauve ring. Surely if this lady attended a grasshoppers' ball she would be awarded a prize for her startling fancy costume!

Locusts and grasshoppers are so much



Photos by Cornelia Clarke

alike that they are often confused. But there is one sure way of telling which is which. True locusts always have short, stout feelers, while grasshoppers, crickets, and katydids have long, wavy ones, often like silken threads. Locusts are sometimes called "short-horned grasshoppers."

### Queer Places for Ears

Grasshoppers, both short-horned and long-horned, do not go through the same wonderful changes as butterflies, bees, beetles, and flies. Young grasshoppers are never grubs or chrysalids. When they break through their eggshells and come out into the big world for the first time, the wee creatures are already very much like their parents. But they have no wings. So although they can hop and skip about and munch green food with their tiny jaws, they can neither fly nor chirp. But they can listen to the music of their elders, for locusts and grasshoppers can hear very well, though their ears are in the most unusual places, where you would never expect to find them. Locusts have ears on their backs, and long-horned grasshoppers, crickets, and katydids have ears on their front pair of legs, just below the knee joint!

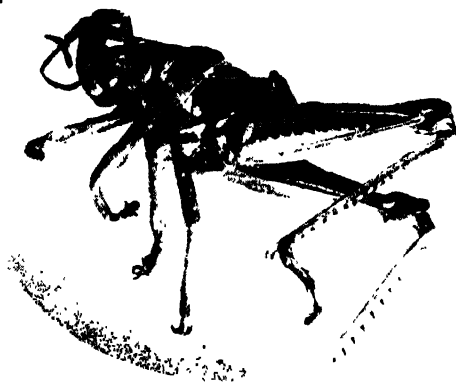
The young insects change their skin several times while they are growing up. Then, after the last moult, their wings appear in

all their splendor; at last they are able to fly and join in the concerts.

The crickets, as a rule, are rather dull-looking insects. The tree crickets are a pale greenish white, but house crickets and field crickets have mostly black or brown

At the left is a grasshopper in a brand-new suit of clothes. His cast-off suit is shown in the oval.

wing cases which bend over at the side when closed and cover the little creature like the lid of a box. They have



bright eyes and loud voices that are heard chiefly at night. For crickets are shy insects and seldom stir from their homes in the daytime—though the field cricket is fond of sitting just inside the doorway of his underground living room and chirping away through the warm summer days.

### The Cricket on the Hearth

The "cricket on the hearth" is a native of Europe. But many years ago some of the cheerful little insects migrated to America and Canada and made themselves thoroughly at home in their new countries. They take up their abode in our dwellings, where they hide away behind stoves and hot-water pipes in the day and come out to cheer us with a song when it is about time to go to bed.

The mole cricket is quite unlike the other members of the cricket family. He is a large insect, about two inches long, with a broad, flat back, and is dressed in a suit of velvety brown. You do not often see him,

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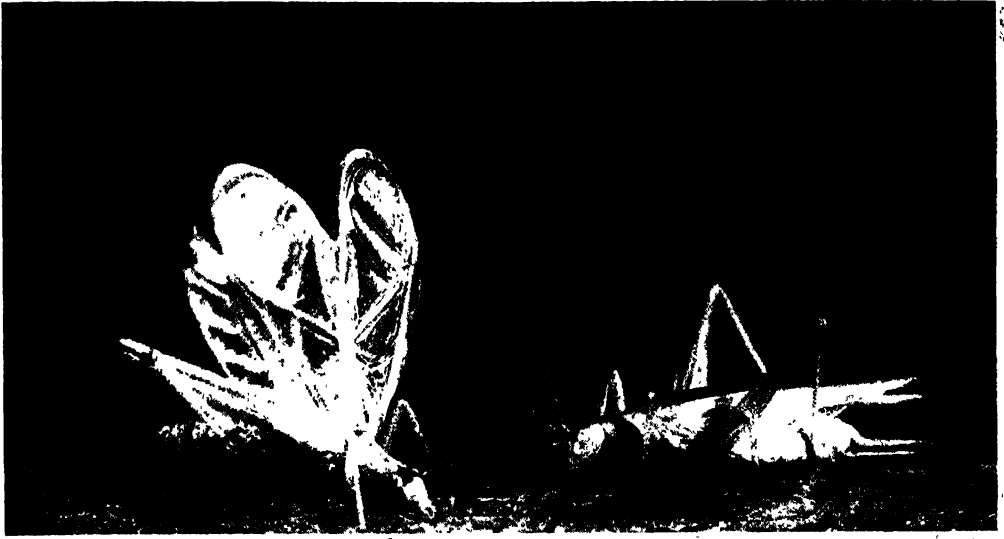


Photo by Cornelia Clarke

The lady tree cricket, on the right, is being courted. Her lover, with wings erect, is singing to her in his

for like his namesake the mole he spends his days below ground; though he often comes up in the evening to sit at the mouth of his burrow and chirp in the true cricket style.

### Feet Made for Digging

The mole cricket has not such long hind legs as the crickets that live in the upper world, and he crawls about instead of leaping; but he has very sturdy front legs, and his forefeet, which are shaped like tiny hands, are armed with sharp claws. This strange cricket lives in damp places where the ground is soft and easy to burrow into. He digs his way with his sharp, strong claws through the soil, just as a mole does, throwing up a little ridge of earth as he goes along hunting for earthworms, grubs, and the tender roots of plants.

The mole cricket is a good mother. She lays a few hundred eggs in a cozy underground nursery and guards them until her babies hatch out. Even then she stays with her young and feeds them until they have come safely through their first moult. Then she evidently considers that the children are old enough to look after themselves. The youngsters stray away, and each tiny

loudest tones—and they are very loud indeed. Of course she is listening through the ears on her legs.

mole cricket sets to work to dig a tiny burrow in the ground for itself.

Grasshoppers and katydids are much brighter-looking insects than the sad-colored crickets. Some have narrow wings and some have broad wings; but they are almost always of a pretty shade of green which blends with the leaves and grasses to which the insects cling, and shields them from the sharp eyes of the insect-eating birds that are always on the lookout for them. The wing cases of many of the broad-winged katydids are so wonderfully like leaves in shape and color and marking that it is almost impossible to find the little creatures as they rest among the leaves on bushes and trees. Their hind wings are always clear and delicate. Some of the grasshoppers in tropical lands have pale blue, rosy pink, or bright yellow wings, with a dark brown border. When they are spread out ready for flight such wings look like pleated dancing skirts.

### Insects That Dress Like Flowers

Brighter still are the wings of the strange insects called mantids that live in the jungles of India and in the East Indies. They are so beautifully colored that they look like

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flowers as they sway gently in the breeze, clinging to the dark green foliage of the tropical creeping plants. Some are so like rare and beautiful orchids that travelers have actually tried to "pick" them before finding out their mistake.

Other mantids mimic green leaves, or brown and withered ones. To heighten the deception they have on their legs strange outgrowths that look like bits of crumpled leaves. Others again are so long and thin and brown that they might easily pass for dry twigs. So eager are these insects to escape notice that nearly all of them are made up to imitate their surroundings as closely as possible. No matter where they live—in clusters of flowers, among thick foliage, on the bark of trees, or upon tall grasses—the mantids imitate their homes and vary in shape and color the better to deceive you.

There is probably no more extraordinary-looking creature or more cunning actor in the whole of the insect world than a mantid, or mantis. The front half of its body is so long and thin that it looks like the neck of a giraffe. It has a queer hammer-shaped head, a triangular face, and absurd bulging eyes. Its two hind pairs of legs are long and spidery; but the front legs are enormous and are always kept doubled up when the insect is sitting down or moving about. It holds them up as if they were arms.

Hour after hour the mantis will sit perfectly still, with its big "neck" raised and its great forelegs held up before its face in an imploring attitude—as if it were trying to say, "Please don't hurt me; I am only a poor harmless beast."

But the mantis is a humbug. It is not the innocent little creature it would seem

to be. Its long forelegs are really horrible traps. The second and third joints have sharp, jagged edges and can be snapped together like the blade and handle of a pocketknife.

As it rests so quietly, half hidden by the foliage, its queer goggling eyes turn this way and that, watching for some unsuspecting insect to settle near by. Then, slowly and stealthily, like a cat stalking a bird, the cunning mantis creeps up. Out shoots one of those terrible legs, closing with a snap upon its prey, and the poor victim is carried kicking and struggling to the mouth of its

captor, who calmly proceeds to bite pieces out of it as if it were a biscuit!

### Mantids Are Cruel Cannibals

Mantids seems to take a positive delight in their cruel sport. They will go on killing one insect after another, taking a few hasty bites out of the victims, and then dropping them on the ground. They are quarrelsome, too. If two of the creatures happen to meet they are almost sure to start fight-



Photo by Cornelia Clarke

"Katy-did, she-did, she-did!" says this oblong-winged katydid. And yet you could hardly find him, in spite of his loud voice, for his pretty suit is just the color of the ear of grain he is standing on.

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•Photos by Victoria & Albert Museum & Cornelia Clarke

ing. They lash out viciously with their deadly legs and try their best to cut each other's heads off; and when one succeeds in conquering the other, it at once makes a meal of its vanquished enemy.

### The Praying Hypocrite

The lady mantis is just as savage in her ways. She is bigger than her mate, and if she is annoyed with him, she is as likely as not to kill him and eat him on the spot.

One of the most famous of these uncanny insects is the praying mantis of Southern Europe—rather a dull-looking creature about two inches long. In olden days, before its real character was discovered, people believed it to be a saintly and highly gifted little creature. When it folded its forelegs it was supposed to be praying; and an old monkish legend tells us that it sang hymns when ordered to do so by St. Francis Xavier.

If you have ever read Dickens' pretty story of "The Cricket on the Hearth," you will know how faithful the little fellow in the oval can be at cheering an English fireside with his hearty song.



The Greeks called it the "diviner" and believed that it could foretell coming events, while the peasant people in many countries declared that if a lost child asked a mantis to tell him the way home, it would raise one of its forefeet and point out the right direction.

Mantids are mostly found in hot countries, but there are several species of the queer insects in the southern states of America and in the Mississippi Valley, where they may sometimes be seen standing motionless in the corner of a windowpane, keeping a hopeful eye fixed on a buzzing bluebottle.

Quite as strange as the mantis, though not quite so barbarous, are the leaf insects and the stick insects—or "walking sticks," as they are often called.

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Leaf insects are natives of India and other countries in the Far East. They are so amazingly like the leaves on the trees and bushes on which they live and feed that the natives of East India firmly believe they are really leaves which in some magical way have grown heads and legs!

The great green leaf insect is very broad and flat, and in shape and color is exactly like a large green leaf. Even the markings on its wing cases imitate the veining of a leaf, while its legs might be small leaflets or broken pieces of leaves arranged round its sides. It is a slow-going, sleepy sort of creature, spending its days peacefully munching the leaves around it and seldom wandering far from home. It never kills and eats other insects, as the mantids do, or interferes in any way with its neighbors. Yet strange to say, if two leaf insects are shut up in a box together without any real leaves to feed on, they will often absent-mindedly nibble pieces out of each other's legs and wing cases instead.

Other leaf insects are brown instead of green, and look crumpled and withered like the dead and dying leaves all about them on the trees. Unless you happened to see one of these leaf actors taking a sly bite at the dry foliage, you would surely never guess that the leaflike thing was an insect.

While the leaf insects are broad and flat,

their cousins the stick insects are long and thin—so thin sometimes, poor things, that they are mere skeletons.

### Nature's Greatest Mimics

The odd creatures are the most famous actors of the insect world. They mimic sticks and plant stems and twigs in the

most extraordinary manner. Those that imitate twigs are bent and twisted just as real twigs are; some even appear to have patches of mould or tufts of moss growing on them to make their resemblance to dead twigs more perfect. Others that live on thorny plants are covered with spikes and prickles.

All the stick insects are timid.

They do their very best to escape notice by assuming rigid attitudes and keeping perfectly still from morning until night. But when daylight dies, the sham sticks and twigs suddenly come to life—as if they

were enchanted creatures released from a magic spell by the setting of the sun. With slow and cautious footsteps they move like specters about the trees and bushes, hastily nibbling at the leaves as they go. The poor things are very hungry. And no wonder! They seldom dare to feed in the daytime for fear someone should discover what impostors they are. So they make the most of the hours of darkness to eat all they can, but at sunrise back they all turn to sticks and twigs again!



Photo by F. M.

In spite of all appearances this is an insect, one of the many that get themselves up to look like a leaf.

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Concealed  
on this page, and  
yet in full sight,  
are a number of  
strange stick in-  
sects, one of  
which is hiding on  
a twig under your  
very eyes.

Photos by F. Martin Duncan and Cornelia Clarke

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Most of these strange insects live in hot, tropical lands. In the patches of long grass that crop up here and there in the great African forests, you may find the cunning grass-stalk insects. That is to say, you may find them if you can! For although there may be one of them on every other grass stalk, very few travelers in the grassy jungles are sharp enough to discover them. They are so exactly like wisps of dried-up grass that you might take one up in your hand, twist and turn it about, and then throw it away without ever knowing that it was an insect. The cunning creature will keep perfectly still and never betray itself by moving so much as a leg or feeler.

The favorite pastime of this stick insect is to clasp a tall grass stalk as if it were climbing up a pole—its forelegs stretched straight out in front of it to form an unbroken line.

The four back legs stand out at odd angles, like forks from the grass, and the insect's broad head passes for a knob in the stem. Really the animal stalk and the vegetable stalk are so alike and so mixed up together that you must be clever indeed to tell which is which.

### Insect Color Artists

Another strange thing about these insect actors is the way they change their color according to the time of year. Just after the African rainy season, fresh blades of vividly green grass spring up on the forest clearings—and then all the grass-stalk insects will be vividly green to match. But the hot sun soon dries the grasses and turns them yellow; so the grass-stalk insects turn yellow too. Later on the grasses are tinged

with autumn tints of gold and brown and red; and the insects change color in exactly the same way.

That insects should change their toilets to suit an occasion at first seems most mysterious; but since the queer creatures feed entirely on grasses, it may be that the color of their food causes the surprising transformation.

In South America and in Australia many

stick insects grow to an enormous size. Some are eight or nine inches long and as thick as a man's thumb. Such gigantic "walking sticks" often do a great deal of harm in the Australian forests, where they sometimes strip the gum trees of nearly all their foliage. Only a few of the smaller kinds are found in North America; they live mostly on walnut trees and oak trees and usually pass unnoticed. In the autumn the stick insects

drop their eggs upon the ground. The tiny things look just like the seeds of plants, and few people would suspect what they really are. Each egg is like a little box with a close-fitting lid at one end. When the baby stick insect is ready to come out of its box, it pushes the lid open, and a queer little thing that looks more like a tiny bit of black thread than anything else makes its appearance and staggers about on its absurdly thin legs.

### The Impudent Cockroach

All the American stick insects are wingless, but many tropical species have delicate gauzy wings and fly from tree to tree late in the evening. When the insect is resting in the daytime its wings lie pleated in long straight folds so close against its body that they hardly make a difference in the outline



Photo by F. Martin Duncan

Can you find the stick insect which is hiding here in plain view?



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of the "walking stick." These wings are not protected by wing cases as the wings of locusts and grasshoppers are, for a stick insect's wing cases are too small to be of much use. However, the outer fold of the flying wings is stiff and strong and when the wing is closed, covers the more delicate folds, like the outer stick of a fan.

The wings of the stick insects—when they have any—are fan-shaped like the wings of the locusts and grasshoppers. So are the wings of the leaf insects and mantids. And for that reason all these insects are classed together and called "straight-winged" insects.

Those unpopular insects, the cockroach and the earwig, are straight-winged insects, too. No one has a good word to say for the cockroach. It really is a most unpleasant creature. As if it knew how much it is disliked, it scuttles away on its long legs in no end of a hurry whenever it sees anyone coming and hides its ugly head in the first dark hole or corner it can find. The cockroach is often called a "black beetle." But this is quite wrong. The insect is not a beetle at all and it is not black, but a dark reddish brown. Although it is such a dingy-looking thing, the common cockroach has some aristocratic cousins living in eastern lands. They are really handsome. They are always dressed in velvety black coats ornamented with large creamy spots or broad orange bands, while a few tropical cockroaches are a pretty pale green.

### Do Earwigs Get in Our Ears?

The earwig is certainly not an attractive insect, but it is quite harmless, and is not so eager to crawl into our ears as some people suppose. The fact is that the ugly little beast very much dislikes the light, and if by chance it finds itself abroad while the sun is shining, it will hurriedly squeeze into any dark hole or crack that is handy—

but this seldom happens to be a human ear.

The large, somewhat alarming pincers at the tail end of the earwig's body are no doubt useful in persuading other creatures to treat it with proper respect. But although they are capable of giving a fairly sharp nip, they are chiefly used for packing away the earwig's delicate hind wings underneath its very stout wing cases. The hind wings are so large that after they are folded lengthwise the earwig is obliged to double them up in order to make them fit neatly under the other pair.

However much we may dislike earwigs we must admit that the earwig is a good mother. Unlike almost all other insects, she guards her eggs until they are hatched, and for some time she takes care of the little earwigs like a

fussy mother hen with a brood of young chicks.

Both cockroaches and earwigs live on refuse, and the way to keep a house clear of

them is to leave nothing around, even for a few moments, which is likely to tempt them. But it is hard to find anything in the shape of food that will not tempt cockroaches. They have been known to eat blacking and emery paper and other unlikely substances. Such palatable food as they do not eat they render unfit for anyone else by leaving upon it a disgusting odor that comes from a substance secreted by glands on their backs. They probably spread disease among human beings, and lately scientists have discovered that they carry cancer among rats and mice. In the Eastern United States a small yellowish-brown fellow known as the German cockroach or croton bug is a great nuisance in houses. He takes his name from the fact that he became very numerous just after the water system from the Croton dam was installed in New York. He may be kept away by the use of roach paste or by sprinkling borax or powdered sodium fluoride in all the cracks.

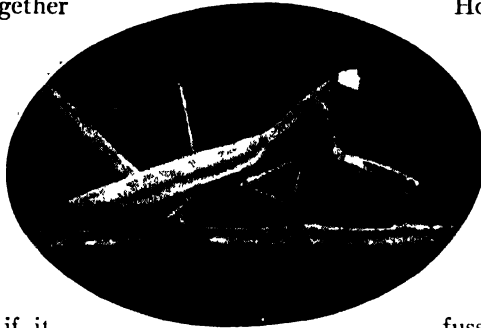


Photo by American Museum of Natural History

This is the praying mantis, which assumes an attitude of prayer while it watches for its food.

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## Reading Unit No. 9

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### THE HORRID HOUSE FLY

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Yearbook Index.*

#### *Interesting Facts Explained*

How to distinguish true flies from other insects, 3-357  
Why house flies are dangerous, 3-357  
The rate of population growth in house flies, 3-358-59  
Habits of the house fly, 3-358

The life story of mosquitoes and gnats, 3-360-62  
Crane flies that leave their legs in your hands, 3-363-64  
Fierce drone flies and robber flies, 3-365  
The African tsetse fly, 3-365

#### *Things to Think About*

Why should house flies be destroyed?  
What would happen if flies were not held in check?  
Why are female mosquitoes more

dangerous than the males?  
What enables baby gnats to breathe in the water?  
Why are certain parts of Africa dangerous to man?

#### *Picture Hunt*

What disease germs may be carried by house flies? 3-357  
What habits of the house fly make it a menace? 3-358  
How do germs stick to a fly's

foot? 3-361  
Where do wigglers spend their days? 3-363  
How can a farmer keep flies down in number? 3-364

#### *Related Material*

How can a man, like a fly, stick to the ceiling? 1-453  
What connection was there between insects and the building

of the Panama Canal? 7-307  
What did Dr. Reed do for mankind? 2-388

#### *Leisure-time Activities*

PROJECT NO. 1: To study the life history of the mosquito, scoop up some water from a stagnant pool with a dip net or inspect rain barrels for wigglers. Put the

water in an empty tank, which should be covered with cheesecloth to prevent the escape of mosquitoes, 3-363

#### *Summary Statement*

Flies are insects with two wings. Since the house fly breeds rapidly in human and animal excretions, it may pick up the germs of typhoid and deposit them on

food or in milk. Cleanliness, and proper garbage and sewage disposal will help us cut down the fly population.

Kill him! Kill him! He is the terrible house fly, as he looks in a greatly enlarged model in the American Museum of Natural History. He and his kind cause thousands of deaths every year. He can keep the germs of typhoid alive in his body for twenty-eight days, and carries on his filthy legs the germs of many another deadly disease.

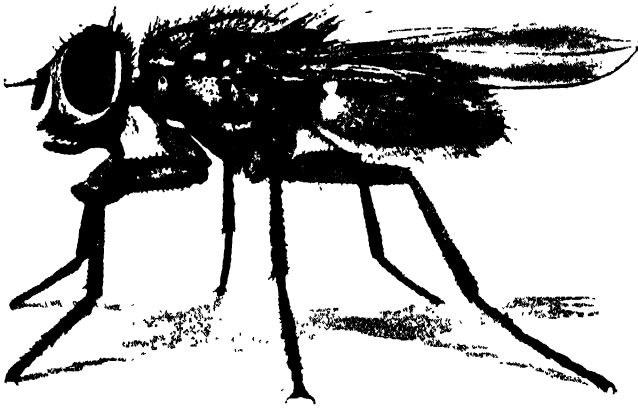


Photo by American Museum of Natural History

## ***The HORRID HOUSE FLY***

***And the Dangerous Mosquito, Which Kill More Men  
than the Worst Wars Do***

**W**HEN is a fly not a fly? Perhaps you will say, "When it is a firefly." But those little beetles are not the only creatures that are wrongly called "flies." So that answer won't quite do.

No, the best answer to the riddle would be, "When it has four wings."

Fireflies, butterflies, dragon flies, May flies, and caddis flies, for example, all have four wings; so they are not true flies. True flies never have more than two.

Flies are the only insects that have only a single pair of wings, though beetles and bugs use their first pair merely as wing cases to protect the hind pair. Where we might expect to find a second pair of wings, a fly has two small knobs fixed on the top of short, slender stalks that look like two little pins stuck into its back. These curious objects are called "balancers"; and although

they do not look as if they could be of any use, they are really most necessary to the insect, for if they were clipped off it would not be able to fly.

There are hosts of these two-winged insects dancing and buzzing and crawling about all over the globe. Although some of them are friendly and useful, most of them are anything but good for us.

The common house flies that buzz up and down the windowpanes and fall into uncovered milk jugs and jam dishes are not the harmless little insects they were once supposed to be. They are really dangerous creatures and behave so badly that we must not allow them to make themselves at home in our houses. They make trouble wherever they go by carrying the germs of typhoid fever and other infectious diseases on their feet and their hairy little bodies.

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Fortunately it is not difficult to get rid of the little pests. They thrive in manure and offal and rotting things. So if our houses and streets are kept as they should be, and no dust or decaying rubbish is allowed to accumulate, house flies and various other harmful little creatures soon die out.



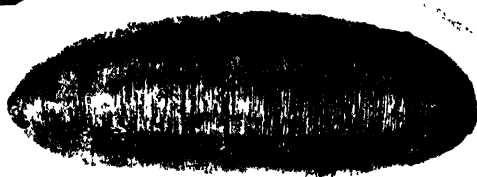
If only two or three flies contrive to establish themselves anywhere the place



will soon be swarming with the troublesome things unless prompt measures are taken to destroy them. For every female fly may lay five or six batches of eggs in a single season, each batch containing over a hundred eggs. From these eggs, in a few hours, wee white legless grubs are hatched. They feed and grow, turn to pupae (pū'pē), and come forth as winged flies, all in the short space of ten or twelve days' time. The new flies lay eggs in their turn—and so the tale goes on. So quickly do the worrisome insects multiply that before the summer is over every female house fly may be a great-great-grandmother and have more descendants than we could count!

A fly has no jaws, so it cannot chew. It sucks up its food through a queer little trunk, or proboscis (prō-bōs'is). On the end of its trunk is a cushionlike sucker. When you see a fly working away with this sucker at a grain of sugar, it is really engaged in dissolving the sugar—turning it into syrup in order to lap it up.

When the fly has finished its meal it proceeds to "clean up," for it is most careful about its toilet. It rubs its forefeet briskly together as if it were washing its hands, smooths



Photos by American Museum of Natural History and  
Cornelia Clarke

Here are pictures of the house fly at four stages in its death-dealing career. In the little round circle are six of its eggs, greatly enlarged. They are always laid in some kind of filth—the worse the better. In from eight to twenty-four hours the disgusting little grub, or maggot, shown enlarged in the rectangle, has hatched and begins to gorge itself upon the filth. As it grows it casts its skin twice. At the end of some five days it is ready to seek a drier place and turn into the pupa which is pictured enlarged in the oval. In warm weather it will be able to step into the world in three or four days, a full-grown fly. In the picture it is enlarged, but nothing could magnify the harm it can now do. It eats all kinds of filth, lays countless eggs, and has a disgusting way of vomiting up its food so that it may eat the more. It is literally crammed with poisonous germs. It may carry at least 7,000,000 of them about with it, and leave 700,000 in every footprint on our food. It is one of our great causes of disease. Never let it live!

its wings, and brushes its eyes with the tufts of fine bristles on its slender little legs. It twists and twirls its head about in the most astonishing manner, just as if the head were set on a pivot—for the short neck that joins the fly's head to its shoulders is no thicker than a fine thread.

Another remarkable thing about the fly is its enormous eyes. They are so big that they almost meet on the top of its head, leaving only a narrow strip of a face. No wonder it is so hard to catch one of the quick little creatures!

The burly bluebottle has just as bad a

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In three weeks a fly has grown children, and in nine generations its descendants may number 324,000,000,-

000,000 flies. No skyscraper is big enough to hold this swarm, which would fill 750,000,000 cubic feet.

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character as its cousin the house fly. It invades the larder at every opportunity and lays its eggs on any meat not put away in the ice chest, loudly buzzing all the time in the most impudent way as if it knew it was spoiling the food. The stable fly and the horsefly are no better. They worry horses and cattle by piercing the skin of the poor animals and sucking their blood, often making them quite ill.

There are other flies that spoil cheese and ham and bacon, causing the loss of thousands of dollars every year. Still worse are the flies whose horrid little grubs devour onions, sugar beets, cabbages, and useful plants of all kinds. But worst of all is the dreaded Hessian fly, a tiny blackish insect only a tenth of an inch long—but the smallest insects often do the greatest damage. A female Hessian fly lays her eggs on young wheat, and when the wee grubs hatch they drain away the sap of the growing plants, often ruining the whole crop.

### The Unladylike Mosquito

Then there are the mosquitoes. No one has a good word to say for them. They are out to suck your blood whenever they get the chance, and raise painful bumps on your hands and face. Worse still, in tropical countries they infect their victims with malaria.

It is the female mosquito that does all the harm. Her long sucking tube is armed with a set of sharp, needle-like lancets; with this neat little instrument she punctures the skin of her victims before sucking their blood.

The little male is harmless. He lives on nectar and the sap of plants and never

attempts to drink your blood. You may know him by his beautiful feelers, which are like thick, bushy plumes, while those of his mate are simple threads with only a few short hairs upon them arranged in little circles.

There are many different kinds of mosquitoes, and they are not all dangerous, blood-sucking insects. The harmless ones are usually called gnats. They have shorter sucking tubes, live on the juices of plants, and do not hurt anyone, though they often make a nuisance of themselves by dancing wildly round your head on warm summer evenings.

The life story of a gnat or a mosquito is like a real fairy story. Very early on a bright summer morning, with a shrill "ping! ping!" the little quick-winged

gnat comes flying down to a quiet pool. Lightly she rests upon the surface without even wetting her dainty feet, and quickly she lays one tiny egg after another right on top of the water. She works very fast and before the sun is up she holds between her feet a mass of eggs all carefully glued together in the form of a tiny boat-shaped raft.

Her work done, the mother gnat darts up into the air to spend the rest of the summer day in merry dancing, leaving the cluster of eggs to float on the water.

The tiny raft is waterproof, and so well shaped that it cannot sink or overturn. Each wee egg in the cluster has a pointed top and a little trapdoor which is kept tightly shut to prevent the water from flowing in.

All day long the tiny craft floats lightly on the water. Then, early next morning, the trapdoors open and all the gnat babies come tumbling out of their fairy boat. But



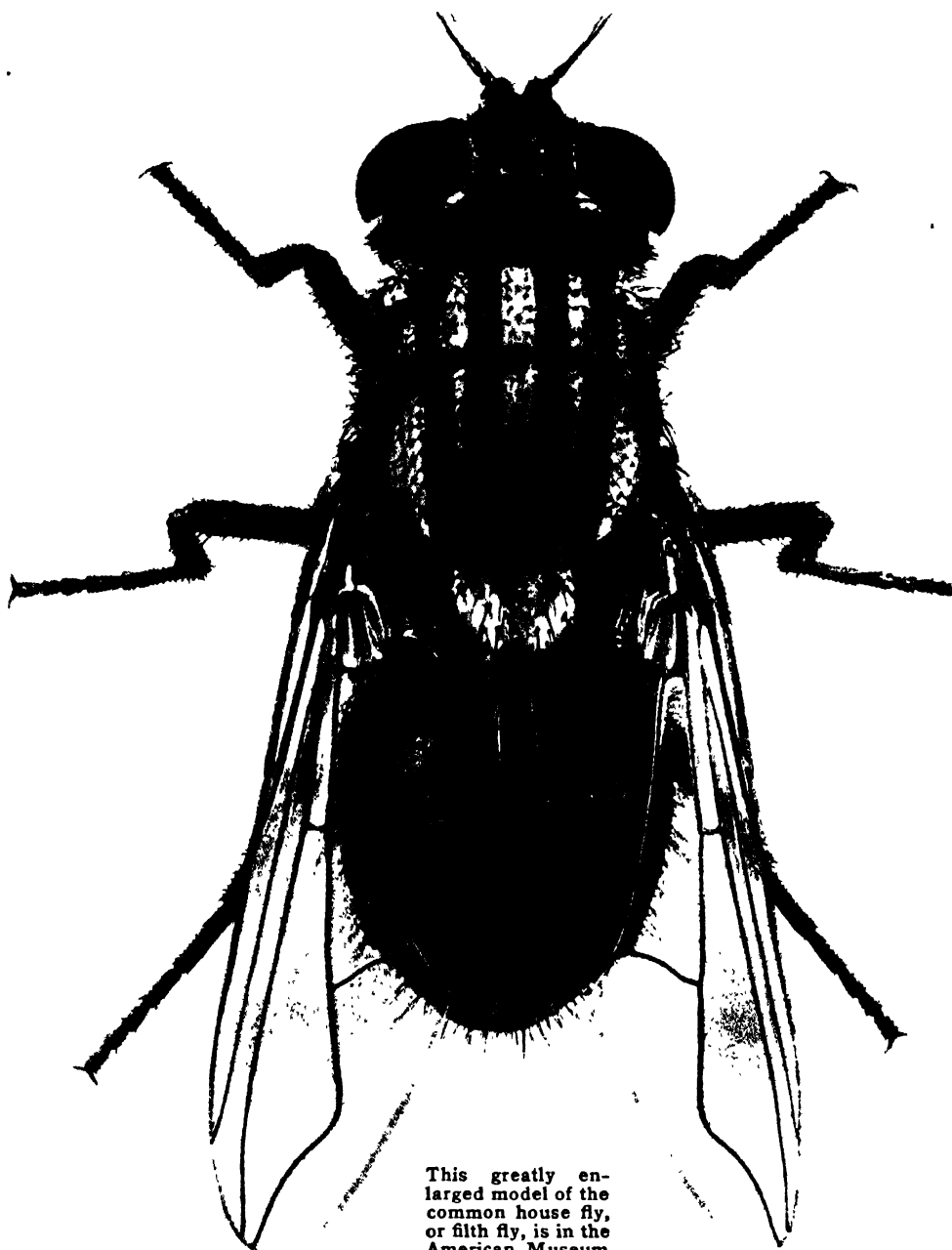
Photo by Cornelia Clarke

This miserable pest is the gadfly, or horsefly, that drives our four-footed friends to distraction. Here it is shown enlarged.

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## WONDERS OF THE INSECT WORLD

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This greatly enlarged model of the common house fly, or filth fly, is in the American Museum of Natural History. If its size were in proportion to the harm it does, it would be much bigger still.

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what odd little babies they are! They are not in the least like their mother. They have long bodies, no legs, big heads and shoulders with stiff bristles sticking out like long whiskers all around, and funny forked tails with one fork much longer than the other.

These queer little "wrigglers" spend most of their time hanging head downward in the water, all bunched up together as close as can be. The tips of their tails—which are really breathing tubes—are pushed just above the surface of the pool to take in oxygen from the air. The little creatures jerk themselves about like acrobats, as they lash the water with their whiskers, sweeping invisible particles

of food into their mouths. But they are timid little beings. If so much as a shadow passes overhead, they all dive down to the bottom of the water, where they plunge and wriggle about in a state of the wildest commotion. As soon as the trouble passes, they all come up again to crowd together, upside down, at the top of the pool, just as before.

### How a Gnat Grows Up

The queer gnat babies grow very fast. Like all young insects, they cast their skins from time to time—each time coming out a little bigger than they were before. If all goes well and they are not gobbled up by some hungry monster of the pool, the little creatures will be full-grown in about ten days' time. Then they moult once more; but this time when they change their coats they change their shape as well.

### The Young Gnat Wears a Helmet

The long-bodied, fork-tailed "wiggler" disappears. In its place is an absurd little object that seems to be wearing a huge diver's helmet! The young gnat has, of course, become a pupa (pū'pā). But instead of resting quietly, as most insects do, while its final

and most wonderful transformation is taking place, the strange little thing is as active as ever. It bobs about in the water and constantly rises to the surface to take in a supply of air through two trumpet-shaped horns on the back of its helmet. The funny little creature does not feed any more. It cannot.

The big helmet, which entirely encloses its head and shoulders, is tightly sealed up; so it would be quite impossible for the pupa to eat, even if it wanted to.

This stage in its life soon passes. Within that clumsy-looking helmet the head, the gauzy wings, and the slender legs of the little gnat are growing. The time is near when the ugly water baby

must leave the dark pool where it has passed its infant days and rise, as a winged insect, into the sunlit air.

When the thrilling moment of its escape arrives, the pupa rises for the last time to the top of the pool and pushes its big helmet clear above the surface of the water.

As it dries in the air the helmet cracks and splits, and through the rent the little gnat appears and stands, weak and trembling, poised on its old pupa skin.

"The quick-winged gnat doth make a boat  
Of his old house wherewith to float  
To a new life."

But all is not yet safe. If it slips, the little gnat will be drowned, for it is no longer a "water baby." It stands quivering for a while on its old house while its wings dry and stiffen in the warm air. Then, taking courage, it darts aloft to join its sisters and brothers in a merry dance.

Numberless little midges, punkies, and other wee flies that whirl in millions over the pastures and meadows have been water babies for the first part of their lives, living in pools and ponds, puddles and ditches until they were ready to take the air as perfect winged flies.

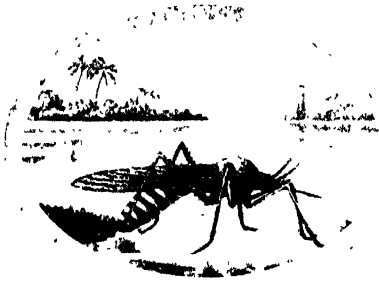


Photo by American Museum of Natural History

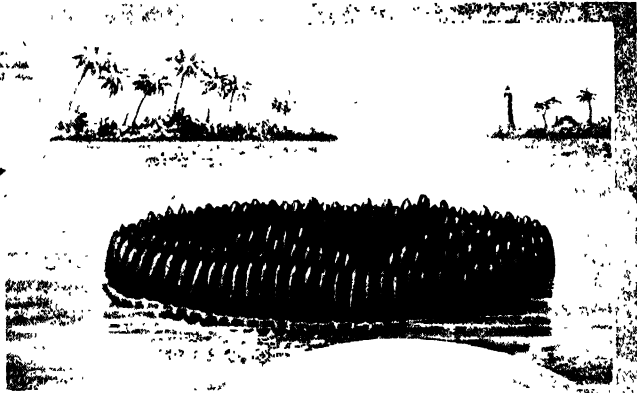
This model from the American Museum of Natural History shows the female of the *Anopheles* mosquito, which carries malarial fever. It is enlarged, of course, but not in proportion to the harm it can do.



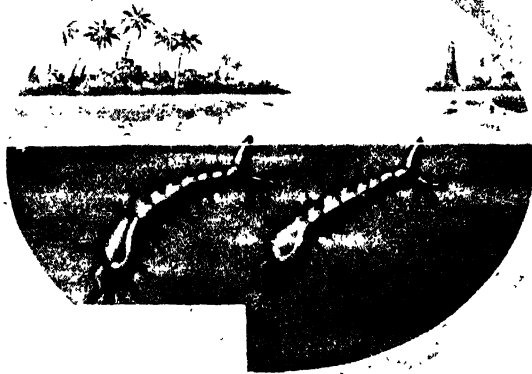
## WONDERS OF THE INSECT WORLD



Above is the common *Culex* mosquito laying her eggs. Of course she is greatly enlarged, as are the eggs also in the picture at the right, where they are shown floating on the surface of the water.

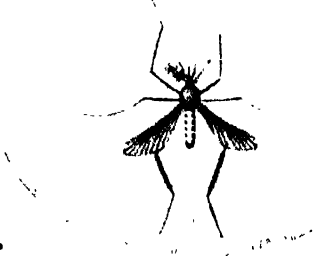


Although so many insects live in fresh water or pass some part of their lives there, they do not care for salt water and hardly any are to be found in the sea. An exception to the rule is the queer little long-legged tide-rock fly that runs about on the wet rocks on the seashore in California. It does not seem to mind being drenched by the salt spray, and flutters about, half



When the mosquito's eggs hatch out they are the "wigglers" of our standing pools, and if they were greatly enlarged would look like the creatures above.

When the mosquito larva turns into a pupa, it looks like the ones at the left, though of course it is much smaller.



When the adult mosquito finally splits its pupa skin and rises from the water, it will look either like the male at the left or the female at the right—but of course it will be smaller than in the pictures.



flying, half running, just out of reach of the full force of the waves.

Old daddy longlegs, who often flies in at the window to pay us a friendly visit on a warm summer evening, is not nearly

so graceful as his cousin, "the quick winged gnat." He staggers about on his absurdly long legs, tries to scorch his wings in the lamp, buraps into things, and flops over in the most ridiculous way. Yet "daddy" is

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quite a harmless person—although some people are terrified at the sight of the big, clumsy fellow. He neither bites nor stings. His trunk, which looks like a very long nose, is intended only for lapping up the juices of plants—not for sucking your blood.

### He Leaves His Legs behind Him

The daddy's long legs seem very awkward to manage and are so delicate that



they break off at the slightest touch. Strange to say, this does not appear to distress the curious fly, for if you catch a daddy by the leg he will fly off leaving it in your hand and dance away quite as merrily without it. That is why one so seldom sees a daddy longlegs with his six legs all complete.

But a daddy's long legs are not designed for dancing on windowpanes. They are intended for walking over grass, where they are really quite convenient. There "mammy longlegs" lays her eggs, stabbing little holes in the earth with her sharp egg-laying tube and leaving an egg in each hole.

In their young days, it must be said, daddies are not so well-behaved as when

they are grown up. They are strange-looking wormlike grubs called "leather jackets" on account of their very tough skins; and they do a great deal of harm in pasture lands by gnawing the roots of grasses.

Daddy longlegs is one of the crane flies. He has a great many relatives, some so small that they may easily be mistaken for midges; but you may always know a crane fly by the curious V-shaped mark on its shoulders.

The giant crane fly of California is the most distinguished member of the tribe. He can boast of being the largest of all true flies. He measures two inches in length and over four across his outspread wings; and as for his legs! three finer pairs are seldom to be met with in the insect world.

The bright and graceful little flower flies that hover like tiny humming birds over the flowers all through the hot sunny hours of a summer's day now poised almost motionless in mid air, now darting away swift as a lightning flash are welcome visitors to our orchards and gardens.

Photos by Cornelia Clarke and American Museum of Natural History

If you ever own a farm, see that the barnyard is neat, like the one on the right, where everything is clean as a new pin. There is no refuse for flies to breed in, and no stagnant water for mosquitoes. But if your farm is littered and dirty, like the one on the left, you will always be pestered with flies, and will wonder why your children should always be falling ill.

flies, in their black and yellow banded suits, are so like small wasps that you might easily be deceived by their looks if you did not notice that they had only a single pair of wings —which shows at once that

they are true flies. Others are very like bees, and they hum and buzz and crawl in and out of the flower cups just as real bees do.

Flower flies—or hover flies, as they are sometimes called, from the way they hover in the air—feed on nectar and honey. So they act as pollen carriers, helping the flowers to form their seeds. But it is while they are wee fly grubs that they are most

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useful, for then they feed on troublesome little plant lice—just as the ladybird grubs do. The flower-fly grub is a soft, pale-green little creature, shaped like a pear, with a wee round mouth at the small end. It moves about, stretching and drawing up its little body in a sluglike way, seizing on the plant lice, sucking them dry, and dropping their empty skins. The tiny creatures feed day and night for ten days before they rest from their labors and turn to pupae. Since it takes them only a moment to devour a plant louse, you can see how many of the tiny pests each baby flower fly must destroy!

The bee flies are even more like bees, with their plump velvet-coated bodies and black and amber coloring. Some of them mimic bumblebees, others hiving bees. Even a spider is sometimes deceived by their looks and hesitates to tackle them when they come blundering into his web.

### He Breathes through His Tail

Most curious of all is the big drone fly that goes buzzing about just as if it were a real bee. It will sometimes pay us a short visit in the autumn, if the weather is dull or cold, and stay in the house buzzing about for two or three days. Since it does no harm, we need not object to our uninvited guest.

The drone fly starts out in life as a queer little grub with a very long tail. It is then called a "rat-tailed maggot." It lives in muddy puddles or stagnant water, and keeps its tail well up in the air. For, as I dare say you have guessed, its "tail" is really a breathing tube through which the little creature draws in its breath.

The flower flies and the bee flies are all well-behaved, peaceful insects, but the big, hairy, ferocious-looking robber flies bear a very different character. They are bold bandits of the insect world, who live by hunting and killing other insects in the most savage way. They lie in wait on the ground or on some low-growing plant. Then with a fierce "buzz" they fly up and chase their victim through the air, pouncing on him and stabbing him in the back with their stout horny beaks. So bold and fearless are the robber flies that they will even attack and kill wasps, dragon flies, and fierce tiger beetles.

One of the most terrible members of the fly family is the dreaded tsetse (tsēt'sē) fly of tropical Africa. It carries germs of a disease known as tsetse fly disease, or nagana, which it gives to animals, and of the dreaded sleeping sickness, which it transmits to man. It is an inconspicuous dark-colored fly, with a pair of wings that it folds one on top of the other lengthwise along its back. Its sharp sucking tube sticks straight out in front of its head, and is inserted into living creatures to draw the blood which is the fly's only food. Sometimes it gorges itself to twice its own weight; and if its victim is suffering from one of the diseases just mentioned, it carries the germs to the creatures it bites within the next few days. Some varieties of tsetse fly carry nagana, others sleeping sickness. These flies are interesting in that the female does not lay eggs, but every two or three weeks bears a grub that digs its way into the earth and turns to a pupa. Finally it emerges as a mature fly, and starts upon its deadly work.

How is it that a fly can run up a windowpane? You must at some time have tried the simple trick of putting a very small tumbler over your mouth and sucking in the air. The tumbler will stick to your mouth as long as you hold your breath. Now in every leg a fly has a little tube that reaches from its breathing apparatus down through the bottom of its foot. Every time the fly plants its foot on the ceiling or the windowpane, it sucks up the air out of this tube and so is held firmly, just as the glass is held firmly against your mouth. And just to make things doubly sure, on the bottom of each foot it carries a sticky pad, to give it a steadier foothold.



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# WONDERS of the INSECT WORLD

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## Reading Unit

No. 10

### INSECT ARMIES

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How locusts almost wiped out the settlers of Salt Lake City, 3-367-68  
How cultivation keeps locusts in check, 3-368  
Fighting swarms of locusts in Egypt, 3-369-70

The musical cicada's life story, 3-370-73  
Battalions of army worms, 3-374  
The life of hidden armies of termites, 3-374-79  
The appalling damage done by termites, 3-379

#### *Things to Think About*

Why did Salt Lake City set up a monument to gulls?  
What happens during a locust "migration"?  
How does a cicada spend its life?

How can queen termites produce such large colonies?  
What happens to a termite swarm?  
Why must termites be destroyed?

#### *Picture Hunt*

Why should the tent caterpillar be destroyed? 3-367, 372  
How do Arabians fight locusts? 3-369  
Why is fall plowing destructive to eggs of locusts? 3-369

Where do young cicadas live? 3-371  
How large are some termite nests? 3-375, 377, 379  
Where are the sewers of a termite nest? 3-378

#### *Related Material*

What butterfly flies in great numbers? 3-281-82  
Why do ants swarm? 3-322-23

What mollusk riddles wood as a termite does? 3-155

#### *Leisure-time Activities*

PROJECT NO. 1: Catch a cicada. If it is a male, it will buzz as you hold it. Study its musical apparatus.  
PROJECT NO. 2: Visit a nat-

ural-history museum and study termite nests, the damage done by termites, and their enormous queen.

#### *Summary Statement*

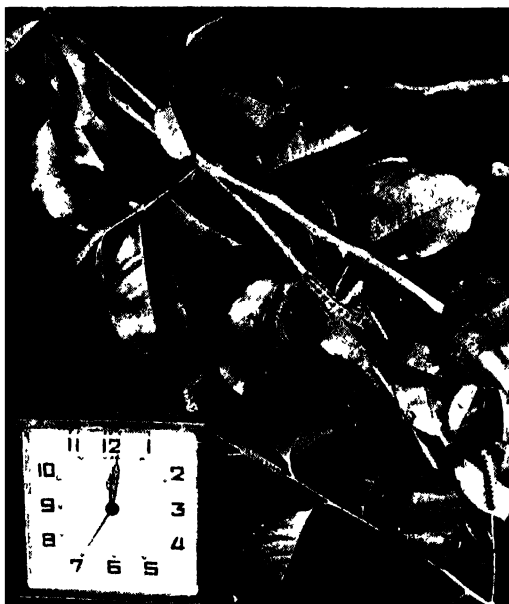
History records that many lands have been invaded by hungry locusts that eat almost everything in their path. The United

States has its share of these migrations, but plowing turns the eggs up to the frosts and so holds down the locust population.

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Photos by J. C. Moss

This is what a few tent caterpillars can do in an hour on a branch of wild cherry. In a very short time they



will strip the whole tree of its foliage. The tent they sleep in is shown on a later page.

### INSECT ARMIES

#### *Sometimes They Are Big Enough to Hold Up a Railway Train*

**T**HERE is a great story of a brave little band of men and women who long years ago founded beautiful Salt Lake City in the midst of the towering Rocky Mountains.

For many a weary month they had journeyed all the way from the Atlantic coast, right across the great plains of North America, with their children, their tools, and their household goods in great covered wagons—for there were no railroads in those far-off days.

They climbed over the top of the first ranges of mountains and settled in a wonderful valley surrounded by hills on every side. There they hastily built huts and cabins to live in through the coming winter. Men, women, and children all set to work with a will to raise crops of wheat and vegetables so that they should not starve when the provisions they had brought with them were all gone.

• They tilled the ground, sowed the good seed they had carried safely for so many

hundreds of miles, watered the dry land, and waited patiently for the coming of spring.

At last their labors were rewarded by the sight of the first green blades pushing their way up through the dark earth, and soon the fields were covered with tender young plants.

Then one day, when everything seemed bright and hopeful, a terrible thing happened. Down the mountain sides a ravening army of black locusts came hopping and crawling. Before the people realized what was happening, the enemy was swarming over the beautiful fields and greedily eating up all the precious green shoots!

The men shouted and rushed about, trying to beat off the locusts. But it was of no use. On and on the creatures came, like the waves of the sea. When they were attacked in one place, fresh battalions would march down on the fields from other sides. There seemed to be no end to the pests.

The people were in despair. All hope of saving their crops seemed gone. Then

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suddenly a sound of beating wings was heard overhead and an army of great white birds came flying to the scene. The gulls of Great Salt Lake, which lies like an inland sea at the foot of the western hills, had come to the rescue. With shrill, excited cries and tremendous flapping of wings they swooped down upon the locusts and started gobbling them up by the thousand. Seldom had the birds had such a glorious feast. They ate and ate until they could eat no more; then they flew heavily back to rest. But fresh companies of gulls kept flying up to carry on the good work, until at last the enemy was fairly routed. Hardly a locust was left alive to tell the tale, and so the crops were saved.

Now this all happened early in the nineteenth century. But it was not the first nor the last time that an army of those destructive insects descended on the crops in North America. Unfortunately, flocks of friendly gulls have not always been at hand to eat them up. And on many occasions the insect armies have been so overwhelming in their numbers that if all the birds in the neighborhood for miles around had flocked to the rescue, they could not possibly have destroyed the locusts—no matter how hungry they were!

Several times have the rich grain fields of the Mississippi Valley been raided by flying squadrons of the dreaded Rocky

Mountain locusts. The hungry insects traveled by air all the way from their strongholds on the plains and plateaus among the mountain ranges in the west—a thousand miles away. High overhead they swarmed

in countless numbers, like silvery clouds in the sky as the sunlight glinted on the millions of fluttering gauze wings. Then down they swooped as lightly and gracefully as a flight of airplanes, covering the ground for miles; and when the invaders rose and flew on their way, not a green blade was left in the once smiling fields and meadows. As the prophet Joel wrote of the locusts in Palestine so many hundreds of years ago: "The land is as the garden of Eden before them, and behind them a desolate wilderness."

Fortunately for us all, such terrible insect invasions no longer occur in North America. Now that there are so many farms and ranches on the great northwestern plains, the eggs of the locusts are turned up and destroyed by the plow. Although the insects are still very troublesome, they no longer have things all their own way. Since 1876 the "migrating locusts," as they are

called, have made no very serious raids on the green fields of the Mississippi Valley.

But in Asia and in Africa plagues of locusts occur even now from time to time, just as they did in the days of the pharaohs—though luckily at fairly long intervals.



Photo by Chamber of Commerce, Salt Lake City

This monument in Salt Lake City was not raised to a group of men and women, but to a flock of gulls, who once saved the place from complete destruction by eating an army of attacking locusts.

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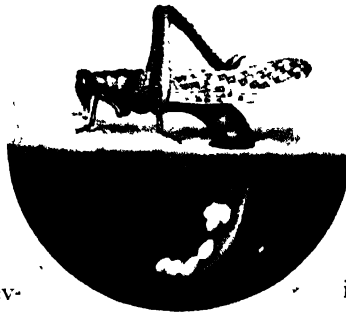
Photo by Wide World Photos

Here is the first line of defense in a war against an army of locusts in the Holy Land. Bedouin Arabs are repairing a wall of zinc plates that has been

stretched across the desert in front of the advancing hordes. Beside the wall a good-sized trench is dug, into which the insects fall. They are then buried.

These insects are larger than the Rocky Mountain locusts and are even more difficult to fight. They breed and multiply unchecked in the vast uncultivated tracts of the East, and when they have stripped the land of every green thing, they set off in search of fresh feeding grounds.

The young locusts, before their wings have grown, set out on their adventures on foot. Driven from home by hunger they move over the land like a living flood, destroying all vegetation in their line of march. They often travel several miles in a day, hopping, leaping and scrambling along in a dense mass, marching straight forward regardless of any obstacle that bars their way.



The locust is laying her eggs in the earth

The advance of marching locusts can sometimes be checked by digging trenches across the route that the insects are expected to follow and lining them with oilcloth; for locusts cannot keep their footing on anything slippery. When they meet such a barrier, thousands upon thousands of the creatures slip and slide and tumble on top of one another, crushing those underneath; and their triumphant march is broken.

But if the army is on wings you cannot stop it in this way. Clouds of flying locusts will sometimes appear, darkening the sky as they pass high overhead. When they are known to be on the way, everyone prays that the wind will change and blow the insects out to sea, or that violent rainstorms will arise to destroy them before they alight and ruin the country.

### How Armies of Locusts Are Checked

If they arrive on the banks of a stream, the water will not stop them. The whole army plunges in, struggling and pushing and clutching at floating leaves and straws, and climbing on top of one another till they form a floating bridge from bank to bank right across the stream. Some of them are drowned, but most of the army finally lands safely on the opposite side of the stream.

### Fighting Locusts in Egypt

For several years a country will be fairly free from migratory locusts. Then suddenly, when people are beginning to forget all about them, the appalling insect armies again make their appearance and are just as bad as ever. As late as 1930 a plague

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of locusts swept over Arabia and North-western Africa. Although fifteen hundred tons of the insects were killed and two hundred tons of eggs collected in Egypt, the damage done was terrible. An army of large red locusts came flying over the country. Their ranks were twelve miles long. Here and there a regiment paused and settled on a green spot,



No wonder Pharaoh and his people were disturbed when Moses brought the plague of locusts upon them! This picture will give you some idea of what things were like in the Holy Land when the locusts came in 1930. The camera which they seem about to devour was being used to take pictures of the havoc they had made, and the automobile they are so resolutely attacking was carrying one of the officials in charge of the work of extermination.

teen-year cicadas" (sī-kā'dā) were at one time a most terrible plague to American farmers. From their habit of suddenly appearing in enormous numbers and fairly eating up the land, cicadas are often called "locusts." But this is quite wrong. A cicada is a bug, not a straight-winged insect, as a locust is.

Now although we often speak of all insects in a general way as "bugs," the name rightly belongs to a particular kind of insect that has a sharp, piercing beak and can only take liquid food. There are a great many of these creatures in the insect world,

leaving the ground bare when they rose again. In some places swarms of the locusts were three feet deep upon the ground. They actually held up trains by settling in masses on the railway tracks.

Everything possible was done to fight the plague. As many as 75,000 men were sent out to attack them, armed with 200 tons of liquid destroyer and 140 flame throwers. The battle raged between the men and the insects for weeks before the invaders were finally routed; and the battle fields, when the fight was over, were indeed a sorry sight.

### What Is a Bug?

Although they have never been quite so bad as the migratory locusts, the "seven-



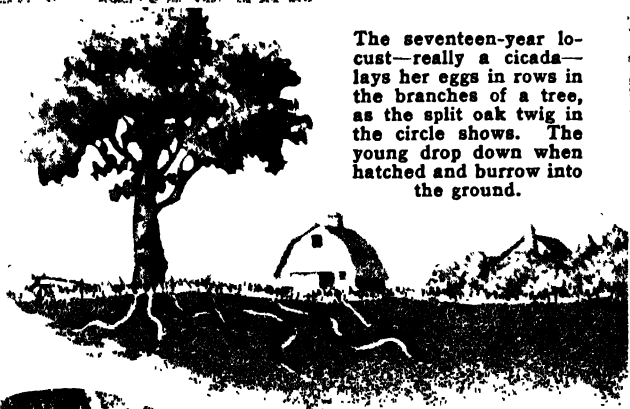
Photo by Wide World Photos

living on the land and in the water; many of them are very tiny and most of them are troublesome. They do no end of mischief by sucking the sap of plants and trees in farms, orchards, and meadows; and others weaken our domestic animals by piercing their skins and sucking their blood.

But to go back to our seventeen-year cicada—one of the largest and most entertaining of the bug tribe. This insect has



## WONDERS OF THE INSECT WORLD



The seventeen-year locust—really a cicada—lays her eggs in rows in the branches of a tree, as the split oak twig in the circle shows. The young drop down when hatched and burrow into the ground.



The young cicadas make their way through the earth till they reach the tree's roots, as shown above. There they stay for seventeen long, dark years, living on root juices. At last they struggle upward and come out into the sunlight, as one is doing in the cut just below.



When they reach the air, the young cicadas climb the trunk of a tree, as the procession at the left is doing. Then their skins split open, and the grown insect steps out into the world, ready to make the air resound with merry but monotonous song.



At the right a beautiful new seventeen-year cicada has just split its skin down the back and is off to see the world. Its old shell is standing empty down in the corner.



Photos by American Museum of Natural History and Cornelia Clark

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gained its curious name from its habit of turning up in overwhelming numbers, in the same district, once in every seventeen years—"and that is once too often," as a Kentucky farmer remarked after one of their rare and unwelcome visitations.

The cicada is a big, stout insect with the usual sharp, piercing beak with which all bugs are armed. Its four transparent wings are arranged over its back like the slanting roof of a cottage. Two great bulging eyes, set sideways on the head, somehow make the cicada look as if it were squinting at you, while in the center of the forehead are three tiny simple eyes that glint like colored jewels, the one beauty the lumpy-looking creature possesses.

However, though they are not beautiful, the cicadas, like the locusts and grasshoppers, are first-rate musicians. At least, the male cicadas are. But instead of playing the fiddle they perform upon the drum, and are said to be the noisiest insects in the whole world.

The cicada's musical instrument is part of his anatomy. Underneath his body

is a hollow cavity partly covered by two sounding plates. The cicada does not beat his drum. He makes it vibrate by working the strong muscles attached to the plates, and produces a loud booming, chirping sound that some people admire, though others say it reminds them of the whistle of a locomotive, the noise made by a distant threshing machine, and the croaking of frogs all going at the same time! Sounding plates inside the insect's body increase the noise and broadcast the "music" far and wide.

The female cicada has no musical instrument, but she has a remarkable egg-laying tube armed with a double-headed saw. With this handy tool she drills a number of neat little grooves in living twigs on trees and bushes, and packs a dozen eggs or so in each one. As a female cicada arranges four or five hundred eggs in this way, she has plenty to do through the long sunny days without playing the drum or indulging in other foolishness.

The eggs in the twigs soon hatch out. But the cicada grubs do not stay in their snug little nests. They drop to the ground, push their way into the soil, and disappear from view. And for seventeen long years the strange little creatures are neither seen nor heard.

Buried deep in the soil, the young cicadas live all that time in perpetual darkness, slowly worming their way through the ground and sucking the rootlets of the trees and plants. But at last, when their seventeenth birthday is approaching, the cicada grubs creep up toward the light once more and begin to

make preparations for leaving the dismal underground world. They change their skins and alter their appearance slightly, but they do not spin cocoons. They are still able to move about, and at this stage in their lives are usually called "nymphs." Sometimes the nymphs make funny little chimneys of earth, which stick up two or three inches above the ground. There they spend a day or two until it is time to come right out into the open. Others do not make chimneys but just hide away under stones and sticks until they are ready to moult their skin



Photo by Cornelia Clarke

In the pictures at the opening of this chapter you may see an example of the destruction a few tent caterpillars can work in one short hour. Here is the nest in which they sleep a beautiful silken web thrown over the branches of a tree. Whenever you see one, destroy it, for the ravenous army it shelters can do great damage.

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On the branch below are three empty pupa skins, all left intact except for a split down the back where the winged insect came out.

The creature in the oval is a seventeen-year cicada just out of the ground, and not yet free of its pupa skin.



Photos by Cornelia Clarke and American Museum of Natural History

for the last time, in their lives.

When the thrilling moment arrives, all the young cicadas come streaming out of their hiding places. The ground seems simply alive with the queer, lumpy things. They swarm up the trees and bushes all around, and cling to the twigs and branches as if they were dazed and dazzled by the strong light—as well they may be after spending so many years in the dark.

They must feel very uncomfortable, too, poor things, for their skin hardens in the fresh air, so that each of them finds itself enclosed in a stiff shell. But they have not long to wait in this condition. The hard skin cracks all down the back, and the cicadas, quite grown up at last, squeeze their way out of their old shells.

Pale, ghostly things they look at first; they are almost colorless, and their wings hang limply down as the insects crowd together, clinging to the leaves and twigs and the bark of the trees. Gradually they darken in color, their wings grow firm and stiff, and in a very short time the cicadas are ready to fly and drum and enjoy their new-found liberty.

And enjoy themselves they certainly do, in their own peculiar fashion. They take complete possession of the woods and plantations all around, and gather together in hundreds and thousands upon the branches of the trees. And while the females dig their beaks into the green leaves and suck out the sap, leaving the leaves dry and shriveled, their mates cheer them on in their

work of destruction by drumming for all they are worth. The forests ring with the sound of the drums, and the branches of the trees are sometimes bent and broken

by the weight of the insects.

This does not often happen now, and we may be glad of it. Much of the land in which the cicadas bury themselves for the first seventeen years of their lives has been built over, still more has been brought under cultivation; and the perky little English sparrow—who was introduced into the country some years ago to wage war upon the insect pests—has done his best to reduce the strength of the destructive armies. The drumming of the cicadas is still heard in the land in the early summer, but the insects no longer assemble in such enormous swarms.

### A Warrior in the Wheat Field

The cicadas do not all take so long in growing up. The thirteen-year cicada of the southern states spends thirteen years underground, while the big black and green dog-day harvest fly, which is another member of the cicada family, comes up to the light and changes to a perfect winged insect when it has only been two years down below.

Another troublesome insect, known as the army worm, often plays terrible havoc in the grain fields in many parts of the country. Of course he is not really a worm but a black caterpillar, with green and yellow stripes; and he finally becomes a small dull-brown moth.

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Swarms of army worms sometimes attack growing wheat and nibble almost every young green blade. Then having done all the mischief they can in one field, they march off in detachments to another one and spoil that too.

There is another army worm in Southern Europe that is quite a different kind of insect. It is a tiny thing, not more than a quarter of an inch long, with an almost transparent body and a wee round black head, which gives it rather a knowing look.

This little army worm does no harm. It is even rather useful, as it lives and feeds on decaying leaves. Millions of the tiny creatures often swarm under the trees in woodland districts, though they are so small that they are hardly noticed among the fallen leaves. But when the time comes to change into chrysalises, the funny little things collect together in hundreds of thousands. They form ranks, sixty or seventy abreast, and march through the woods in a long, straggling line that winds in and out of the roots and the trunks of the trees like a great gray snake.

Suddenly the army halts, and the insects all roll themselves up together into a big round ball. For some time this tangled ball of wriggling grubs lies on the ground. Then, in some mysterious way, it begins to shrink. None of the insects break away from the ball, yet slowly and steadily it grows smaller and smaller; until at last, just as if it had vanished into the air, the ball completely disappears! Whatever can have become of those thousands of grubs? Well, the cunning little creatures have not melted away. They are all safely hidden in the

ground. The army had halted and rolled itself up on a nice soft spot of deep, black leaf mould. Then the grubs at the bottom of the ball immediately set to work to dig in, and one after another all the others followed in regular order until not a single army grub was left above ground!

There in the darkness each little grub turns to a mummylike pupa; and when their transformation is complete, a swarm of tiny black midges rises from the ground and dances gaily in the sunlight.

The flying squadrons of locusts, the regiments of drumming cicadas, and the battalions of marching caterpillars are only too plainly to be seen when they choose to invade the land. But in some countries there are enormous hidden armies of insects that cannot bear to appear in public and never show themselves in the open if they can possibly avoid it.

These unseen insects are termites (*tûr'mīt*), strange little creatures often called "white ants." But they are not ants. They are quite a different race of insect folk and not related to the little ant people in any way—although they live together in large communities very much as ants do.

Some termites live inside the trunks and branches of dead trees. Some live outside living trees, but are always under cover just the same, for they plaster the trees with clay or chewed wood pulp, making huge shapeless nests and

long covered ways that shelter them from observation.

Other termites live in deep underground cities where living rooms, storerooms, nurseries, and great vaulted halls have been hollowed out in all directions, and are connected by main roadways and numerous winding passages. Over the chief entrance to their cities the termites often raise great

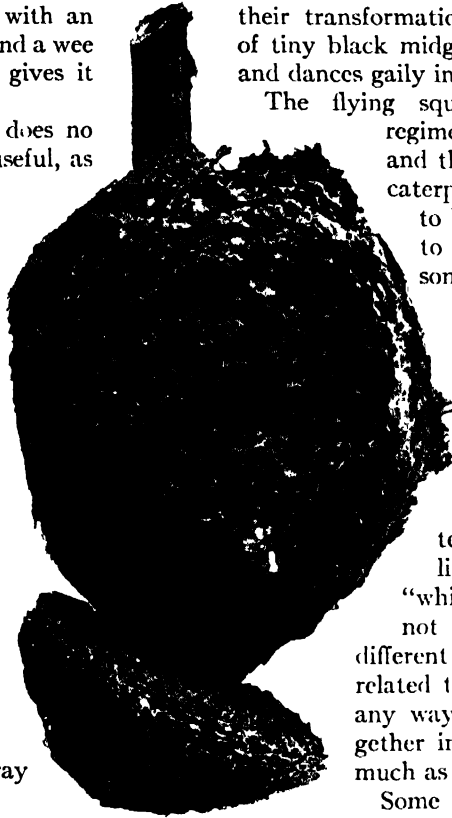


Photo by American Museum of Natural History

Termites, or "white ants," build nests of many kinds. This one from tropical America is attached to a small limb.

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Photo by Brown Bros.

Surveyors for the Cape to Cairo railroad in Africa built their lookout station on top of a termites' nest. The walls of such great ant hills are very solid, as is shown by the steps that have been cut into this one.

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mounds of earth, called "ant hills," with the soil they have dug out. These also contain many chambers, galleries, and passages.

In the heart of Africa acres and acres of dry, sun-baked land are covered with such ant hills, some rising singly like tall towers twelve or fifteen feet high, others grouped together like tiny mountain ranges. They are so firm and strong that you may climb all over them without breaking them down. Yet although the hills and the ground under our feet are teeming with the strange little insects, never a termite is to be seen—only by their work do we know they are there.

In every big hill or underground city there are several kinds of termites; a king and a queen, a small army of soldiers, and a large number of ordinary workers, besides quantities of babies and children of all ages. The babies are not legless grubs as true ant babies are. When they come out of the egg they are wee things, with heads, feelers, and six legs all complete. They look like small editions of the workers. Of course the little creatures can do nothing for themselves for some time after they are hatched; so they stay in the nurseries and the workers bring them food until they are old enough to take their places among the grown-up termites in the city.

The workers are very ugly little creatures. They have soft, flabby bodies, like dirty-white crumpled sacks, while their heads and shoulders are dark oily brown. They do all the work of the city—care for the children, collect food, attend the king and queen, build the mounds, and tunnel out the chambers and roadways underground. They must really have quite enough to do to keep everything going.

The soldiers are larger than the ordinary

workers. They have big, queer-shaped heads and huge jaws like scythes. It is the soldiers' duty to guard the colony; so while the workers are busy, the soldiers march up ready to fall upon any daring creature who attempts to interfere with them.

### Sixty Eggs per Minute

Strange to say, both the soldiers and the workers are usually blind. But they are not deaf. They have ears on their front pair of legs, just as grasshoppers have, and appear to talk to one another by jerking their heads and shoulders in a very curious way. It is supposed that by moving the back of its head against its shoulders, a termite makes little sounds which its companions can hear and understand—though of course the sounds are much too faint for our ears to catch.

The king is quite an ordinary-looking termite, though a good deal bigger than the workers. But the queen—well, she is simply enormous and just like a sausage or a white bolster, with a tiny head and shoulders on one end and six feeble legs. Few people have seen a queen termite, for she spends her life hidden in the royal apartments deep down in the earth, where she does nothing but lay eggs all day long at the rate of sixty a minute. Both the king and queen have eyes, but as they always live in the dark their eyes can hardly be of much use to them.

At certain times of the year the nurseries in termite cities are suddenly filled with troops of royal children. It is not until they are nearly full-grown that they can be distinguished from the ordinary children of the colony. Then four pretty gauzy wings appear upon their shoulders to prove that they are real princes and princesses, who may, perhaps, become the kings and queens of termite cities of their own.

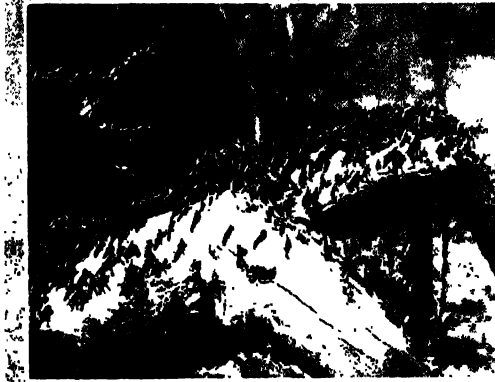


Photo by American Museum of Natural History

**These locusts were tired of flying, so they settled on a great limb. If the limb had been slender they would surely have broken it.**

## WONDERS OF THE INSECT WORLD



Photo by Brown Bros

This great termites' nest is only one of many at Elizabethville, in the Congo in Africa. Half of it had to be cut away to make a road, but there is very little danger of its caving in. It is too solid for that.

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Above is an ideal plan of the inside of a termites' nest. Such a city may be more than twenty feet high, and has ventilation and sewerage. The big room at the top is for storing air. In the one below, the youngsters are probably kept. The king and queen live in

the smaller one near the bottom, with cells for their servants all around them, and storehouses for food for the half million inhabitants. You can see where the eggs are kept; in the oval is a closer picture of them. The sewers are at the bottom of the nest.



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We say "perhaps," for it is really most unlucky to be a prince or princess in the insect world. They nearly always come to an untimely end, for with one or two exceptions the chances are that all the royal termite children will be dead a few hours after they have gained their wings.

Of course they do not know this, and all the young royalties are in a hurry to leave their old home and try their wings. So out they all come and fly off in a great swarm. But the moment they show themselves out of doors, all the insect-eating creatures from far and near are after them. Birds chase them through the air, rats and reptiles pounce upon them and gobble them by thousands when they alight upon the ground. When the excitement is over, nearly all the termites are gone, and the greedy birds have eaten so many they can hardly close their beaks!

Only a few royal couples manage to escape from the general slaughter; and as soon as they settle on the ground they shed their wings and look about for shelter. If they are near a termite city where a king and queen are wanted, some of the workers will come out and fetch them in; if not, they may start a new colony for themselves. But once they are safely underground they will never come out again. The workers take care of them and feed them both, and the queen grows bigger and bigger until she is perfectly helpless and cannot even move about the royal apartment.

### Dead Wood Is Their Favorite Dish

Some termites cultivate different kinds of fungus in the underground cities to make a kind of "mushroom cake," most of which is given to the children. The favorite food of the grown-up insects is wood—dead wood—which they chew and chew again

until there is nothing more to be got out of it. Decaying trees, old stumps or posts, any sort of wood will serve them so long as it is dry enough. To get the wood the termites are of course obliged to leave their homes. But as nothing will induce them to show themselves above the ground, they take the ground along with them, building little tunnels of earth as they go, so that they always move from place to place under covered ways. The strange little insects will carry their tunnels right up a tree twenty or thirty feet high in order to reach a dead branch at the top. The earth is carried grain by grain, twisted about in the workers' jaws until it is soft and sticky, and firmly rammed into place at the end of the tunnel. But the cunning little masons never show themselves. They work always on the inside. In some of the African forests, nearly every other tree is plastered with the winding tunnels of termites.

Now so long as the termites just eat the fallen tree trunks and the rotting

stumps and branches, they are really doing good work. For the forests would soon become impassable if the dead wood were not cleared away. But when they invade houses and destroy property, it is quite a different story. And if there is a house within reach of a termite colony, it is almost impossible to keep the little pests out of it.

The mischief they do is appalling. Telegraph poles, instruments, books, clothes, houses, furniture, anything that comes in their way they will devour. They never show themselves but they are there at work just the same, hollowing out the legs of your favorite chairs or eating up the supports of your house until one day it comes crashing down upon you. Unhappily, they have lately begun to put in an appearance in certain parts of the United States.



Photo by Field Museum

This strange turret photographed in West Africa is only one of the shapes a termites' nest may take.

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# WONDERS of the INSECT WORLD

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## Reading Unit No. 11

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### OGRES OF THE INSECT WORLD

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The life of the golden-eyed lacewing, 3-381-82

How the lacewing babies destroy harmful insects, 3-382

How the young ant lion traps his

prey, 3-383-84

How the ant lion finally becomes a winged hunter, 3-384

Why dragon flies stay near water, 3-384

#### *Things to Think About*

Why do lacewings lay their eggs on long stalks?

How are baby lacewings useful?

Why does the young ant lion

build a circular pit?

How does an ant lion keep its pit clean?

Where do young dragon flies live?

#### *Picture Hunt*

Why must lacewing eggs be kept separated? 3-382

How is the lacewing fly useful to

man? 3-382

What enables the ant lion to devour its prey? 3-383

#### *Related Material*

What other insect is used by man to kill harmful plant lice? 3-336

How do dragon flies develop? 3-390-92

How are some insects doomed by carrying eggs of parasites on their backs? 3-274

What common insect spends its early days in the water? 3-363

How do robber flies get their food? 3-365

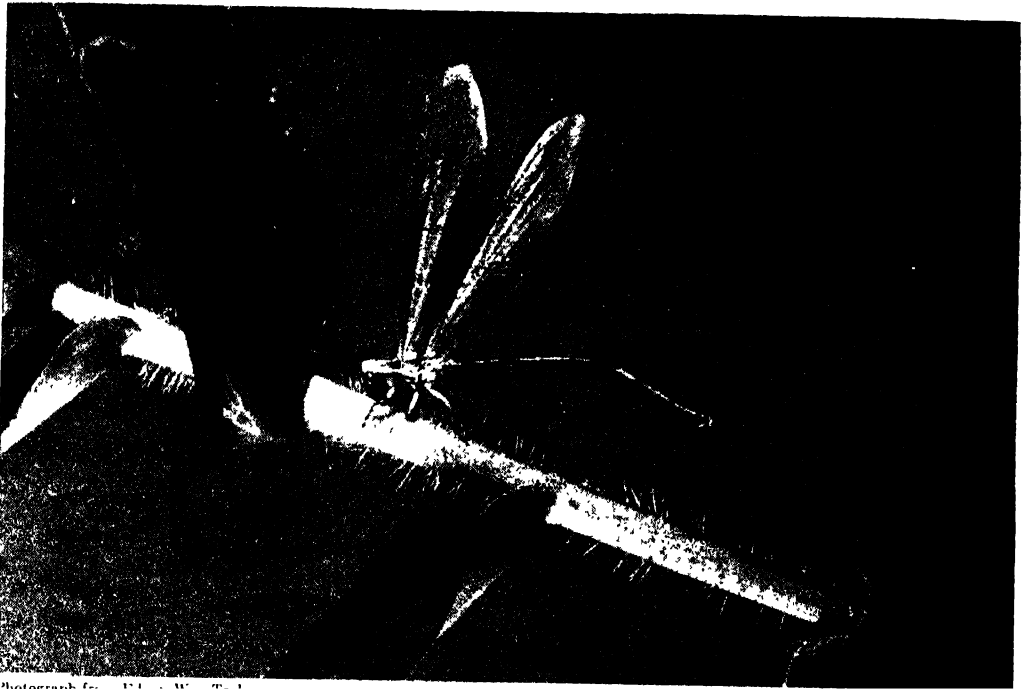
How does a dragon fly get its food? 3-390

#### *Summary Statement*

The golden-eyed lacewing fly lays its eggs on slender stalks. These eggs hatch into larvae called aphid lions because they devour plant lice or aphids. Later these aphid lions spin silky

cocoons, from which they emerge as winged adults. Dragon flies are born in the water; later they become winged flyers and pounce on flying insects near ponds.

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Photograph by F. C. W. M. S.

This dainty ant lion fly is as harmless as it looks, but its past has been horrifying. As a young ant lion it was

accustomed to dig itself a pit in the sand and, lurking

### OGRES of the INSECT WORLD

*Tiny Creatures That Are a Terror to All the Other  
Little Insects within Reach*

**I**F WE keep our eyes open and look about as we walk through the grain fields on a summer's day, we may perhaps find one of the most lovely little insects in the whole of the insect world. It will be moving slowly and quietly over the smooth green leaves of the growing grain. It is quite small, hardly an inch long, and a pretty clear green color. Its wonderful eyes are of shining gold, and its four lovely wings seem to be made of the finest lace, woven by fairy fingers.

•This beauty of the grain fields is the lacewing fly. It is hardly a rare insect. It loves the fields and meadows and often comes into our gardens to visit the flower beds. But the lacewing is a quiet little creature, and its green coloring makes it so inconspicuous that we often pass it by.

If you ever see a lacewing fly, stop and admire its delicate wings, its long feelers, and the way its big golden eyes change color and flash like jewels in the light. But don't touch the pretty insect, whatever you do, for it will cover your fingers with an appalling scent, and you will be obliged to scrub them again and again before you can get rid of it. This, of course, is only the way in which the little lacewing protects itself from its enemies. There probably are not many insect-eating creatures that would care to meddle with it.

As she walks over the green leaves my lady lacewing deposits, here and there, a little cluster of wee creamy eggs. Each egg is fixed separately right at the end of a long slender stalk. So when the baby lacewing hatches out, it finds itself swinging in the

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air—like the “baby on the tree top!” But it does not stay there. The tiny creature climbs down its egg stalk and lands safely on the fine broad leaves to which it is attached.

is their favorite sport, they will attack and devour caterpillars and other insects several times larger than they are themselves. They suck the eggs of any insects they can find; and one strongly suspects that the female

Hanging each one from a tiny thread are the eggs of the golden-eyed lacewing fly, as shown at the left. It is a wise arrangement; it keeps the first-born from eating up the other eggs that are not yet hatched.

lacewing fixes hers on the top of those long stalks to prevent her children from eating one another—which they would certainly do if they could.

The aphid lions prowl about, sucking eggs and aphids and killing all the small insect folk they can clutch with their sucking spears. At last they are

Below is the golden-eyed lacewing fly. It is of great value in destroying enemies of valuable plants.

quite “fed up.” Then they creep away under a leaf or into a



Photos by Cornelia Clarke

The babies of the lacewing fly are not at all pretty. Their small flat bodies bristle with short stiff spines, and they are armed with long slender jaws that have very sharp points—real sucking spears with which they pierce and suck their food.

Enlarge the cocoon of the lacewing fly and it will look like this—a charming little silken casket with a neat round lid attached to the top. The beautiful fly has been caught in the very act of emerging into the world, all ready to devour millions of green plant lice.



These queer little grubs are called “aphid lions”; you can guess from their name how they amuse themselves. They are surprisingly fierce and bold for their size, and although “hunting the aphid,” or plant louse,

there each little “lion” spins a small cocoon of glistening white silk and shuts itself up inside it. The cocoon is like a tiny round

crack in a stalk, and

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box, fitted with a circular lid; and after the little creature inside has rested for a while, it cuts round the lid with its jaws, pushes it up, and comes out as a lovely golden-eyed lacewing fly instead of an ugly little aphid lion.

The ant lion, in its young days, is even more ferocious than the aphid lion. When it is a grown-up insect it is not unlike a dragon fly, with four big gauzy wings and a long slim body; but while it is in the grub stage, it is a horrible little ogre and the terror of the small insects that come within its reach.

An uglier little creature than a young ant lion you could hardly imagine. Its dull-colored, clumsy looking body is shaped like a flattened egg, with a row of warty lumps covered with tufts of black bristly hair all down each side. Its legs are ridiculously small and feeble; its head is square and flat; and its long curved, sharply pointed jaws look frightful enough to scare the life out of any small timid creature.

### An Insect Trapper

Now the young ant lion is no bold hunter. He is much too slow and awkward to catch anything. You see, his legs are so very weak and are fixed to his sides in such a curious way that he is obliged always to walk backward. So since he cannot go a-hunting, the ant lion has to find some other way of procuring his dinner. And this is how he does it.

First he chooses a nice dry spot, where the soil is loose and sandy, and makes a circle on the ground, marching solemnly round in a ring, backward of course, and making a shallow furrow by plowing up the sand with his broad flat body. Stepping

inside the ring, he now scoops up the sand with one of his forelegs, shovels it upon his big flat head, and with a sudden jerk sends the load flying over the border.

He plods away all round the ring until he has made a neat circular trench; then he sets to work to make another trench just inside the first one. This is hard work. And since the leg on the inside of the circle

has all the shoveling to do, the ant lion will give it a rest now and then by turning round and working in the opposite direction.

Round and round he goes, plowing the sand, shoveling it upon his head, and flinging it as far away as he can outside his excavations. At the end of each round he draws nearer to the center of the circle; and when at last he arrives there, the persevering little creature has scooped out a round, funnel-shaped pit about two inches deep and three

across, with steep, sloping sides.

Well, there the little monster is, down at the bottom of his pit. And very tired and hungry he must be. For unless some silly insect walked right into his jaws, which is not likely, he can have had nothing to eat all the time he has been working so hard. But the ant lion's task is finished now. There is nothing more to do. So he shuffles himself down into the sand at the bottom of the pit and patiently waits for his dinner.

### The Ogre in His Lair

He seldom has long to wait. For whenever you find an ant lion's pit, you may be quite sure that there are some ants' nests not very far away. Now ants are very inquisitive folk. As they hurry to and fro, all very busy about one thing or another, one of them is



Photo by F. Martin Duncan

This is the remarkable larva of the ant lion. Its merciless ways make it a terror to all small insects.

## WONDERS OF THE INSECT WORLD

sure to spy the little pit in the ground and stop to have a look at it. She runs up and peers over the edge. There, down at the bottom, she sees a terrible pair of jaws sticking up from the ground. Not liking the look of this, she turns to go. But, oh dear! the loose sand gives way under her feet, and before she knows what is happening, the inquisitive ant is slipping and sliding down the sloping sides of the pitfall! The hungry ant lion grows very much excited when he sees his dinner coming. He shovels up the sand with his flat head and flings it up in showers, which fall upon the struggling ant and knock her back again every time she tries to scramble up to the top. And so the poor thing slips farther and farther down the hill and rolls right into the cruel jaws of the horrid little ogre waiting below.

The ant lion has plenty to eat. Not only ants, but flies and little beetles and insects of all kinds are always falling into his pit. He sucks his victim dry, much as a spider does; then putting the empty skin on the top of his head, he jerks it as far from the pit as he can. In this way the ogre keeps his pit clear, and there is nothing to frighten careless or inquisitive insects away from the trap.

### The Ogre Becomes an Angel

The ant lion lives for quite a long time in his pit before he changes to a pupa. But at last his appetite fails. He then sets to work to make a round ball of sand, fastening the grains together with fine silken threads—which he spins from a spinneret at the tail end of his body. The ball is hollow and lined with silk to make it soft and comfortable inside. In this curious cocoon the ant lion rests for a while. Then, when his transformation is completed, he comes forth and flies away as a graceful winged insect.

But although he is so changed in every way, the ant lion does not change his name. He is still called an ant lion, though he no

longer lives in a sand pit and devours unwary ants. The ant lion is now a hunter and chases his prey on the wing. But he is rather shy and timid and does not fly about in the sunny hours of the day as the bold dragon flies do. He spends most of the day resting among the leaves on trees and bushes and comes out in the dusk to hunt the moths and flies that flutter about in the twilight.

### The Habits of the Ant Lion

The ant lion is much the same shape as the dragon fly—or “devil’s darning needle”—but is not nearly such a beautiful insect. Its long body is almost black and its wings are usually spotted with dull brown. Ant lions are found, too, in hot, dry, sandy districts, while dragon flies haunt the streams and pools and seem forever on the wing. From early morning to quite late in the evening, they dart backward and forward over the water, flashing in the sunlight with wonderful changing colors of shining blue and green, copper and purple. For a moment they rest, clinging to the reeds and rushes with their long, slender legs. Their great eyes gleam like lamps of copper and gold. Then off they go again, twisting and turning so swiftly in the air that our eyes can hardly follow them. They are the boldest of hunters, and they catch and even eat their prey without even pausing in their flight.

The lovely dragon flies were not always such bright and airy creatures. In their early days they crept about in the mud at the bottom of the pond; there they lurked among the water weeds and pounced upon small water folk that swam by. Slow, dull, ugly creatures they were then; you would hardly think it possible that they could ever be changed into glorious dragon flies.

But the insect world is full of such wonders. The woods, the meadows, the ponds and streams all have marvelous tales to tell—true tales, as fascinating as the most enchanting fairy story ever told.

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# WONDERS of the INSECT WORLD

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## Reading Unit No. 12

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### THE GAY LIFE OF THE BROOKSIDE

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The water babies of stone flies, 3-387-88  
The life of the buffalo gnat, 3-388-90  
How dragon-fly babies live, 3-390  
How dragon flies get their wings,

3-390-91  
Damsel flies, 3-391  
The house-building activities of caddis flies, 3-392-93  
The spider that lives in a bubble, 3-393-94

#### *Things to Think About*

How do nymphs change to adults?  
What keeps young buffalo gnats from being carried away in a swift stream?  
How do dragon-fly nymphs get their prey?

Can dragon flies sew up your ears?  
Why must caddis worms build houses of stone?  
What keeps spiders that live in the water from drowning?

#### *Picture Hunt*

Where do baby horse flies live? 3-388  
Where do May flies spend most of their lives? 3-389  
Where do dragon flies lay their eggs? 3-386

What becomes of large dragon-fly nymphs? 3-386  
How do damsel flies differ from their nymphs? 3-391  
Do water spiders breathe through gills? 3-394

#### *Related Material*

What enables the water-boatman bug to stay under water? 3-403  
What enables whirligig beetles to live under water? 3-397

Why do mosquito wigglers often rise to the surface of the water? 3-362-63  
What do brook fishes live on? 3-233

#### *Leisure-time Activities*

PROJECT NO. 1: In early or late spring scoop up some mud from a pond or brook. Pick out the nymphs and grubs and put them in a jar. Make an aquar-

ium of pond insects. Try also to get insects that live on the surface of the water, 3-387, 394, 396-404

#### *Summary Statement*

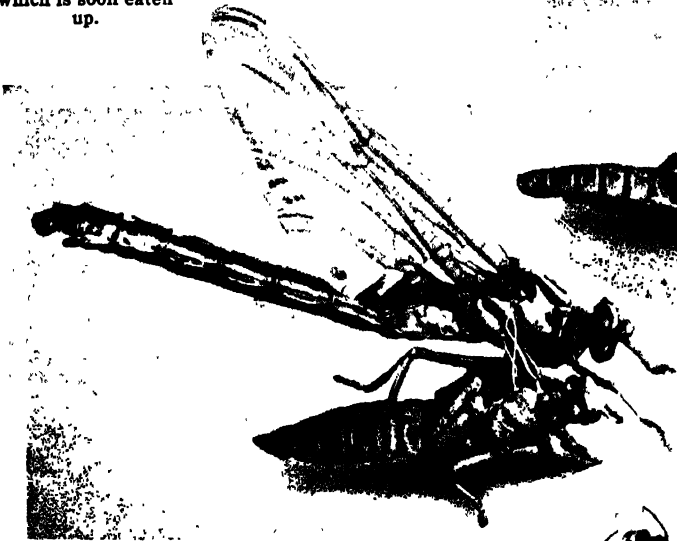
Water insects that fly spend their earlier stages in the water, where they hunt their prey. When they reach the proper stage of development, they climb a

weed and split their skin down the back. A winged adult emerges, ready to hunt for its prey in the air.

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The water dragon, or grub—shown above—which emerges from the dragon-fly egg is a flat, grayish little creature which crawls about in the mud, more occupied in looking for food than in keeping out of the way of its enemies. It can swim after a fashion, and when it sees an appetizing little insect, will move toward it very cautiously until it is within grabbing distance. Then the powerful jaws go out and close upon the little prisoner, which is soon eaten up.



One sunny day in May or June, when the water dragon is fully grown, he begins to feel very strange—even his appetite has left him. So he crawls out on the bank and sits dejectedly. Soon the lump on his back cracks—as shown in the upper rectangle—his coat rips, and a weak, limp little insect—shown in the center oval—pulls himself out, leaving an empty shell behind him—as shown just above. He has never seen wings before and there is nobody around to teach him how to use them; but as soon as he is strong enough he flies away.

The dragon fly is a very careless mother indeed. She just swoops down close to the water, lays her eggs a little beneath the surface, and flies off again without a thought as to how her babies will be taken care of. The eggs fall down to the bottom, and in due time, hatch—that is, if they are not eaten up by one of the many greedy little water folk.



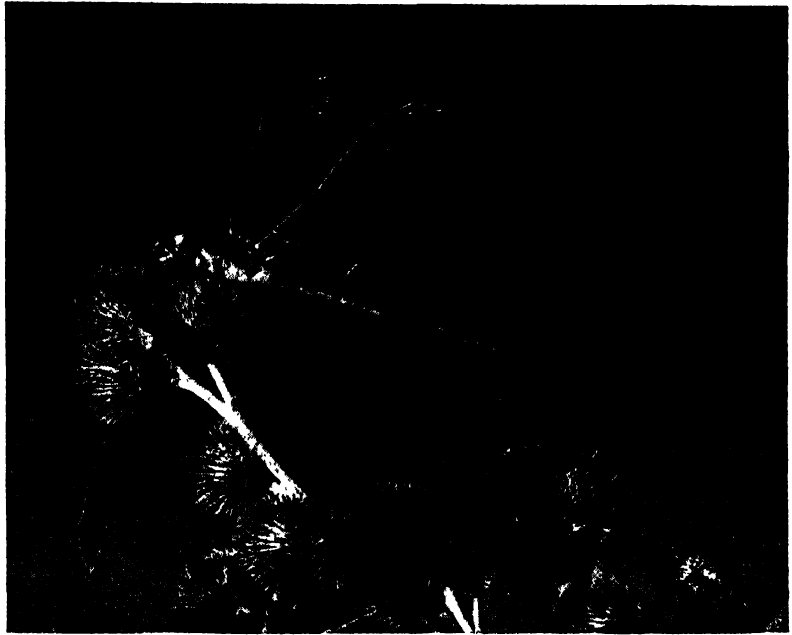
The glittering dragon fly below is resting on a bulrush. Soon he will go "zooming" off, like a tiny airplane, to search the pond for his dinner.





Like a winged jewel the green dragon fly, or devil's darning needle, darts about over the summer stream or comes to rest on the plants growing along the brookside. No insect could be more harmless and few so beautiful.

Photograph from Edwin Way Temele



### *The GAY LIFE of the BROOKSIDE*

#### *The Amazing Story of the Dragon Fly and of Some of the Other Citizens of the World of the Babbling Brook*

**A**S THE days grow longer and warmer, life in the water world grows more and more exciting. Now is the most delightful time of all the year to wander by the waterside, to rest in the shade of a leafy tree and watch the cool silver stream bubbling and sparkling in the sunshine, or the glorious summer clouds sailing like great white ships across the sky and casting moving shadows over the still pool that gleams like a polished mirror below.

Now all through the joyous summer days the water population is forever increasing and changing. Whole armies of small water folk are making ready for the last and most surprising change in their marvelous lives. Swarms of bright-winged flies keep rising from the water to whirl and dance in the sunshine or drift in mazy rainbow clouds away over the meadows, while down below fresh batches of water babies are constantly hatching out to take the place of those who have left their nursery for the outside world.

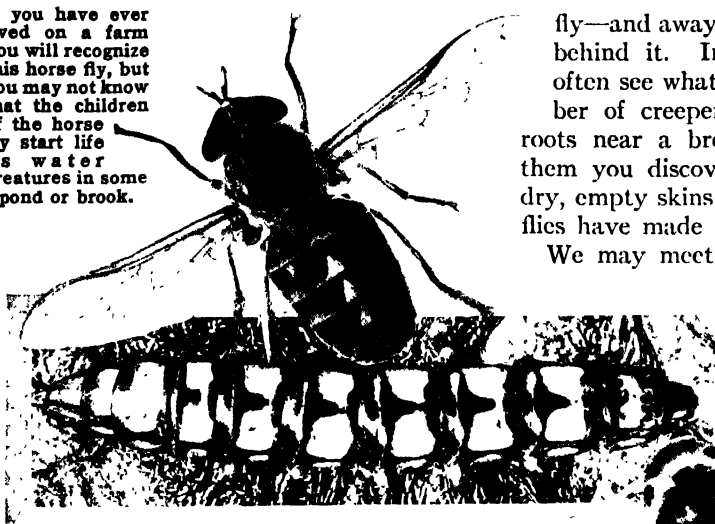
Glorious dragon flies are on the wing, even in the hottest hours of the day, when nearly all living creatures are glad to rest for a while in the shade. Like fairy airplanes they fly backward and forward across the pool, now darting, swift as an arrow, from side to side, now dipping and curving in their flight, now poising motionless in mid-air while the sunlight glances on their jeweled armor and quivering, outstretched wings.

Under the stones at the bottom of a rippling brook some small dusky creatures with long forked tails are often to be found, living side by side with the young May flies. If you lift the stone that shelters them they will scuttle about in a great state of excitement and try to hide themselves under another stone.

These quaint little water folk are usually called "creepers." They are the children of the stone flies—those rather heavy-looking insects, with four brown or green gauzy wings and two funny little tails behind, that

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If you have ever lived on a farm you will recognize this horse fly, but you may not know that the children of the horse fly start life as water creatures in some pond or brook.



Photos by Cornelia Clarke and British Museum

go whizzing along almost in a straight line, flying low over the ground on the banks of a stream. It seems doubtful whether these creepers are very good roommates for the soft and rather helpless young May flies, for the creepers are bigger and stronger, with powerful jaws for chewing up their food, and they would surely think nothing of chewing up their neighbors if provisions were scarce at any time.

Both the young May flies and the stone-fly creepers are called "nymphs"—though anything less like the charming water nymphs we read about in fairy tales it is difficult to imagine. They do not turn to pupae (pū'pē)—that is, they do not rest for a while in a neat little case—as most insects do before they change into perfect insects. Instead, they move about as usual until the time arrives for the most thrilling moment in their lives.

### From Ugly Nymph to Dainty Fly

When the creeper is ready for its marvelous transformation from an ugly little nymph to a dainty fly with pretty brown or green wings, it crawls out of the water and clings to a stone or the root of a tree growing by the side of a brook. There, as it rests quite still, its old skin begins to swell in a most alarming manner. Then, suddenly, the skin splits down the back and out steps the stone

fly—and away it goes, leaving its old coat behind it. In early summer you may often see what appear to be a large number of creepers on the stones and tree roots near a brook; but when you touch them you discover that they are only the dry, empty skins from which the little stone flies have made their escape.

We may meet with many strange water babies in almost every pool and stream, but among the most amaz-

The larva of the horse fly looks like one of the jointed wooden caterpillars you can buy in a toy shop. It lives in wet mud or under an old water-soaked log at the edge of a pond.

To the left is the "nymph" of a stone fly. These awkward creatures are usually found clinging to stones at the bottom of a stream.

ing are the infant buffalo gnats, or "black flies"—those tiny, stout, humpbacked flies that make themselves such a nuisance to fishermen and campers, and sometimes drive cattle frantic by settling on the poor beasts in swarms and biting them unmercifully.

### Comical Buffalo Gnats

But when they are water babies, these wee flies are harmless enough, and are the most comical little creatures you can think of. They look like ridiculous dolls wearing tightly fitting black dresses right down to their feet. Really these young buffalo gnats have no feet, but two short legs, which are chiefly employed as suckers, stand out from the shoulders like stumpy little arrows. On either side of each round head is a bushy tuft of hair, which waves wildly in the water as the absurd little objects stand up on end and bend and bow as if they were being most polite to one another. They cluster together in little groups, or sometimes in large colonies, on rocks and stones or the under side

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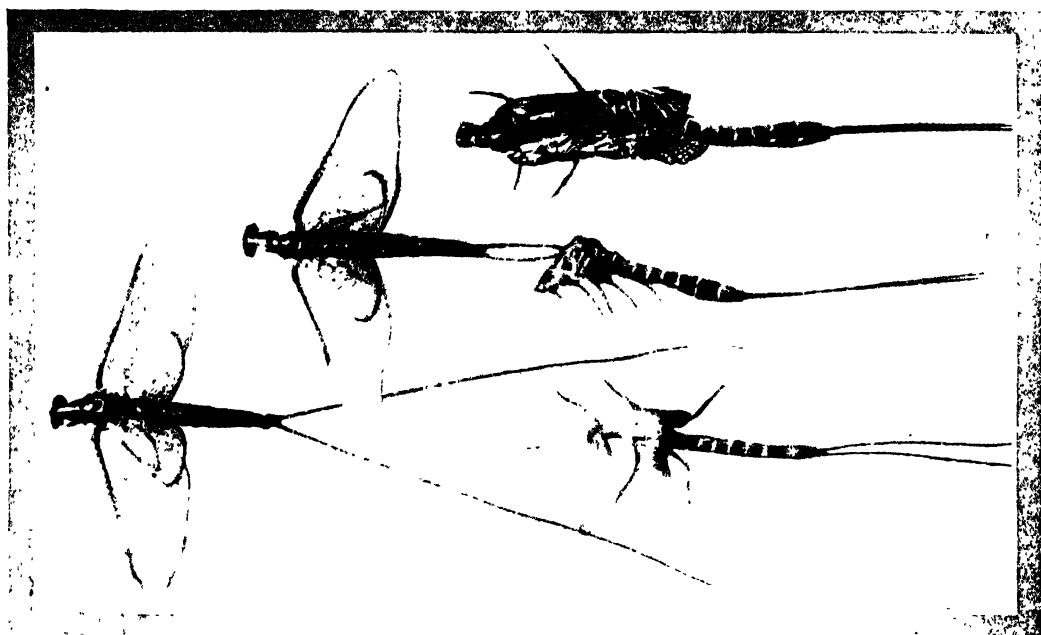


Photo by Cornelia Clarke

One of Nature's most astonishing miracles is the transformation of an ugly May-fly "nymph" into a dainty May fly. The old skin splits open at the back and the

animal slowly drags itself out. The long process of growth can hardly be a waste of time, though the adult May fly lives only a little while.

of submerged leaves; but they are so very small that unless you have a magnifying glass you cannot really see what they are like.

### Life on the Edge of a Waterfall

These strange little water folk choose—of all places—a swift stream to live in. They are actually quite at home on the edge of a waterfall, where one would think they would all be washed away in the rushing waters. But although they are sometimes swept from their positions, the tiny things are not lost. In a moment or two they are creeping home again against the strong current in a most astounding way.

The fact is that each mite has provided itself with a safety line, along which it crawls like a looper caterpillar. The young buffalo fly can spin threads almost as well as a spider can, and it weaves a perfect network of silken ropes from point to point all around its residence. Along this it can travel at lightning speed when it wishes to change its position. The silk comes from its mouth; so if by accident the little creature is swept

away, it is always attached to a safety line by which it can haul itself back again.

When the time comes for the young buffalo fly to prepare to leave its nursery, it weaves a silken cocoon like a tiny neat pointed pocket and disappears within this neat little contrivance. The cocoon is fixed to a rock or the stem of a water plant and is at first closed; but as soon as the little creature inside has changed to a pupa, it pushes up the lid and out of the top pops a queer-looking head still adorned with long tufts of hair.

### Born in a Bubble

For about three weeks this odd little pupa remains in its pocket with its hair tufts waving over the top to draw a supply of water inside. Then the pupa case inclosing the buffalo fly swells with air until it is almost as round as a ball. Suddenly it splits, and out comes a tiny bubble of air. It rises swiftly to the top of the water. There the bubble bursts and vanishes as completely as Cinderella's pumpkin coach; the little fly steps lightly on the surface film,

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pauses for a moment, then spreads its wings and mounts into the air.

Did ever fairy prince or princess ride in a more wonderful coach than this little fly, who is carried through the misty water up to the sunshine in a glittering silvery bubble?

### The Water Dragon

Many other water babies besides the little buffalo gnat are so very small that although the weeds and the floor of the pools and brooklets may be crowded with the tiny creatures, you will never see many of them unless you have very good eyes and look very carefully.

But we shall not have much difficulty in seeing a young dragon fly when it is moving about in its home beneath the water, for some of the largest are more than two inches long when they are full-grown, and even the smaller ones are quite big enough to see when they are a few weeks old. No matter whether it is large or small, the young dragon fly is one of the least beautiful of water babies. And as for its behavior! It is so savage that it thoroughly deserves the title of the "water dragon."

A large water dragon has a thick, clumsy body, either broad and flat or shaped like a cigar. Its head is large and flat, its great eyes are dull and bulging, and a more extraordinary jaw than the creature has you would hardly meet with in the water world.

It is the lower jaw that is so strange. It is called a "mask," and is like an enormous hand with a wicked-looking pair of pincers, instead of fingers, on the end of a long jointed arm.

### How a Dragon Kills His Prey

When the dragon is resting or prowling round at the bottom of the pool, this mask is folded back and tucked away beneath his chin. But when some small water creature, an insect, a young newt, or a tiny fish passes near, out shoots this great paw. The nippers seize the poor little victim and carry it to the mouth of the monster, who munches it up with much relish.

The big dragon is not very nimble. He plods slowly along the ground on his some-

what weak legs or swims lazily through the water by swinging his body from side to side. If he wants to, he can take sudden little spurts forward by squirting a jet of water from his tail. But the cunning fellow knows how to get a good meal without the trouble of hunting for it. He lurks among the tangled weeds, where his dull brown coloring makes him practically invisible, and just waits for his dinner to come to him. Every time anything he fancies comes within reach, he merely thrusts out his paw and grabs it.

The dragon lives for some months, or sometimes for a whole year, in the water, killing and eating as many of the water folk as he can catch. So he waxes large and fat, and at intervals he casts his skin in the usual insect manner.

After the dragon has moulted three or four times, a queer little hump appears on his back. Until this happens he is a grub—or a larva—but now he is called a nymph. Inside that hump the glorious wings are beginning to grow.

### The Birth of a Dragon Fly

But the dragon does not alter his ways. He continues to prow around, skulks in the thickets of water weeds, and devours all little water folk who are neither strong enough nor quick enough to escape his clutches.

At last, when he is full-grown, the wily dragon seems to begin to feel strange and uncomfortable. He neglects his food and wanders about in a restless fashion. Two or three times he climbs up the stem of a plant and takes a look around at the outer world, and then scrambles back into the pool, as if he did not much like what he saw there. In the end, however, he leaves his old home. For the last time he crawls out of the water and clings tightly with his legs to a stone, a stick, or a reed stem, or anything that happens to be handy.

There for a while the unattractive insect rests, and waits for the miracle that is soon to happen. Presently his great dull eyes begin to glow, his dingy skin swells and cracks, and gradually the head, the shoulders, the slender legs, and long tapering body are

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drawn out of its old covering—and the dragon fly is free.

For some time yet he clings to his support, pale, limp, and exhausted after his struggle for freedom. But the sun shines on the trembling creature, and the wind

blows softly upon his crumpled wings and quivering body. Gradually he recovers his strength, his body stiffens, his wings unfold and grow firm and dry. The new-born dragon fly takes courage, and like a living flash of light he darts aloft.

You must get up early if you want to see this wonderful thing happen,

for as a rule the dragon fly chooses daybreak to complete his transformation. Dragon flies love sunshine. All through the sunny hours you may see them on the wing—glorious creatures with strong, rainbow-tinted wings and long, graceful, armor-clad bodies glittering with metallic blue, green, copper, and violet. No longer do they skulk in dark corners lying in wait for unhappy victims. Now they boldly hunt their prey like hawks through the air. Each dragon chooses a special "beat" for his happy hunting ground. Backward and forward he will fly over a pond or a stretch of running water, or he will hawk up and down a hedgerow or a green woodland. As he flies, his six slender, spiny legs are brought forward under his head and clasped together to form a kind

of net, and in this "leg basket" the flying dragon catches moths and butterflies, gnats, bluebottle flies, and winged insect folk of all descriptions, and devours his victims without even pausing in his flight.

### Myths of the Dragon Fly

Ignorant people are often afraid of dragon flies. They call them "devil's darning needles," "snake feeders," "mule killers," "horse stingers," and such silly names. But dragon flies are really perfectly harmless to man and beast. Indeed, they are very useful, for they destroy great quantities of mosquitoes and other pestiferous insects.

There are over three hundred different kinds of dragon flies and damsel flies in North America alone, and about two thousand altogether in the whole world. Their wings and bodies are colored in many

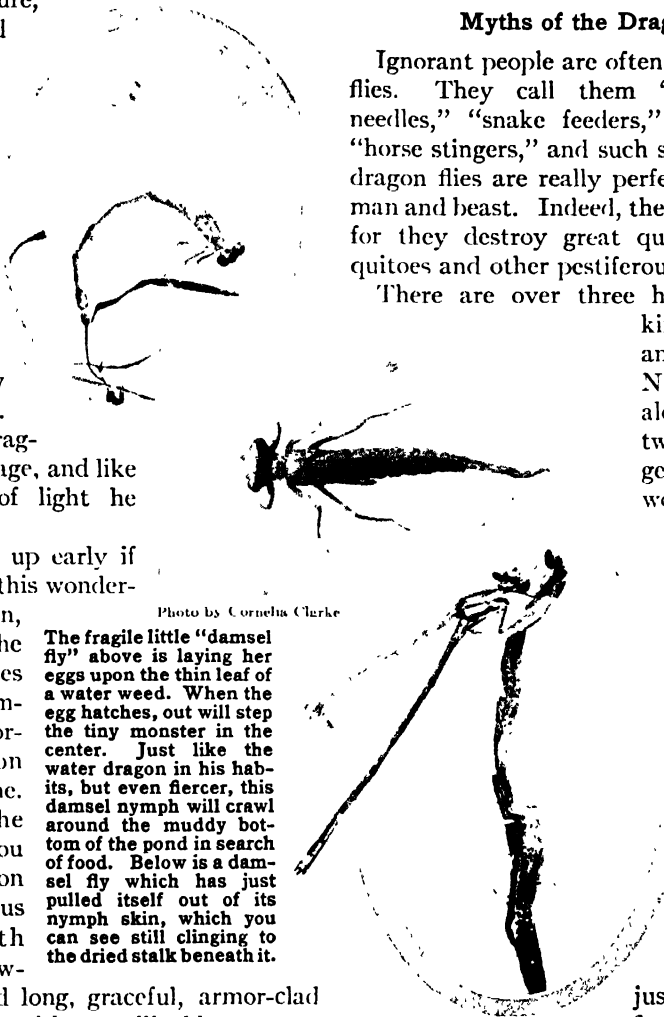
different ways, but all are fine, handsome insects. Damsel flies are smaller than the flying dragons, and have very fine, needle-like bodies and delicate

wings. They are

just as bold and fierce in their ways,

however, and while water babies they are much more lively and active. They may often be seen climbing briskly about the water weeds, hunting and killing all the small creatures they can find.

With so many blood-thirsty monsters as the water dragons, water tigers, fierce diving beetles, and other ruthless creatures about, the water world is indeed a perilous place for small, defenseless water babies. It seems surprising that so many manage to grow up



The fragile little "damsel fly" above is laying her eggs upon the thin leaf of a water weed. When the egg hatches, out will step the tiny monster in the center. Just like the water dragon in his habits, but even fiercer, this damsel nymph will crawl around the muddy bottom of the pond in search of food. Below is a damsel fly which has just pulled itself out of its nymph skin, which you can see still clinging to the dried stalk beneath it.

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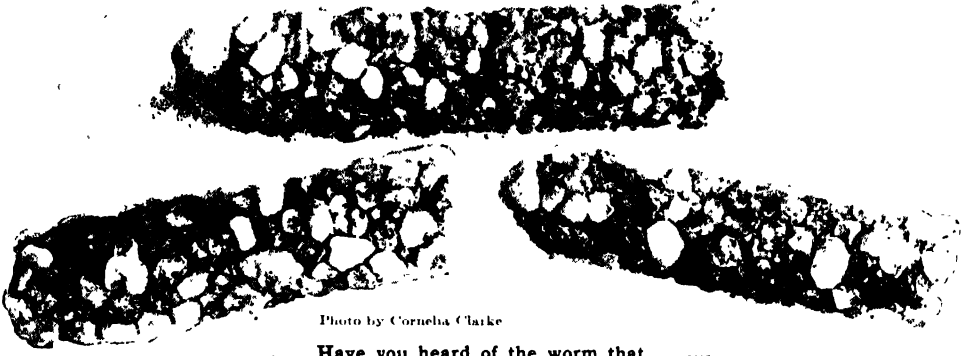


Photo by Cornelia Clarke

and make their escape alive from their nurseries. Yet they do, we know, or there would not be such swarms of merry insects dancing by the water all through the joyous summer time.

Few of these little creatures are able to defend themselves against the strong, well-armed insects which are forever prowling or swimming around. So they do the next best thing; they keep out of sight as much as possible and hope for the best. And as they are so small and inconspicuous, they stand a fair chance of being overlooked by their enemies.

### Little Worms That Build of Stone

But feeble water folk are not all content with hiding in the mud or under stones and rubbish. The caddis worm, for example, constructs a most curious little portable house in which it lives in comparative safety.

The caddis worm is very much like a caterpillar. Its hard, round head and six long legs are protected by a horny skin, but the rest of its body is so soft and white and tempting that it would be a dainty morsel for any hungry creature if it were left exposed to view. But the caddis worm attends to this. As soon as it comes forth from its egg case and finds itself all forlorn in the great water world, the wise little creature sets to work making another case to hide in as quickly as possible.

Have you heard of the worm that builds himself a house of stone and cement? It sounds ridiculous, but that is just what the caddis worm does—and very wisely too, for it protects his soft, plump little body from hungry enemies. Above are some caddis homes, neatly made of pebbles and sand grains, and cemented together with sticky threads which the worm made himself just for that purpose.

There are a great many different kinds of caddis worms. Their cleverly-built houses may be seen in nearly every clear pool and brooklet, all up and down the country, though most of all these queer water babies love a swiftly-flowing mountain stream. Each kind of caddis has its own particular style of house. Some make neat little tubes of sand grains, glued together with sticky silken threads which come from the mouth of the tiny builder. Some choose small stones or tiny snail shells for their building material. Others prefer snips of water weeds, tiny bits of twigs, pine needles, or fragments of straw. And while some of these little workers take no end of trouble to make their houses neat and shapely, others are very careless about their work and just bind all sorts of odds and ends together in a rough-and-ready fashion, so that they look like tiny bundles of rubbish.

### The Strangest Houses in the Stream

Many caddis cases are really beautiful little things. In some of the streams of California they are made of grains of quartz, bits of mica, and other minerals picked up from the bed of the stream; and they sparkle and glitter in the water like gold as they are trundled about by their owners. But the prize for the most novel and artistic little house must surely be awarded to a caddis that makes its case so exactly like a coiled

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snail shell that you cannot tell the difference—until you see a small round head and six thin legs appear through the doorway, instead of the broad foot and the two little horns of a water snail.

A few caddis worms anchor their houses to stones or weeds with ropes of silken threads;

caddis enlarges its house to suit its increased size. Then, when it is ready to change to a pupa, it retires altogether from the world and closes its case with a silken door, or a wall of small stones or chips. In due time the pupa pushes open its door, leaves its little house, and crawls out of the water, where it is soon transformed into a small mothlike fly with four gauzy wings. These are rather dull in color as a rule,

but most of these curious insects ramble

about, dragging their houses behind them wherever they go. The cases are lined with silk, and to this the caddis clings with two tiny hooks at the end of its tail. So there is no fear that it may lose its property while it is taking a walk or foraging for food.

### A Clever Little Fisherman

Most caddis worms are peaceful little creatures. They nibble the weeds as they wander around and do not interfere with their neighbors. But they are not all quite so good and innocent. Some of the larger ones have been seen killing and eating small water creatures, and even pulling tiny snails out of their shells. Most remarkable of all is the "fisherman caddis," who weaves a net of silk and fixes it in the water in such a way that the current carries all sorts of tiny creatures into the snare, and the "fisherman" is sure of a good dinner.

From time to time, as it grows bigger, the

though some caddis flies in the Colorado mountains have lovely snowy wings and pale bluish-green bodies.

Anchored among the weeds in a quiet pool or backwater we may perhaps come across another most charming little water house, a tiny gossamer tent, like a silver bell, that a water fairy might live in. But no fairy lives in this dainty house. It is made and occupied by a small hairy spider. Now an ordinary spider would soon be drowned if it fell into the water and could not scramble out again; yet this spider is quite all right, however long she may stay below. Her house is not filled with water but with air, and she is perfectly dry and comfortable when she sits at home.

### The Magic Robe of a Spider

When the spider comes up to the surface and runs about on the top of the floating lily leaves, as she sometimes likes to do, you would not notice anything peculiar about her. But wait till she goes home again! The moment she dives, the dull little spider's plain brownish coat is changed by the magic touch of the water to a dazzling robe of silver

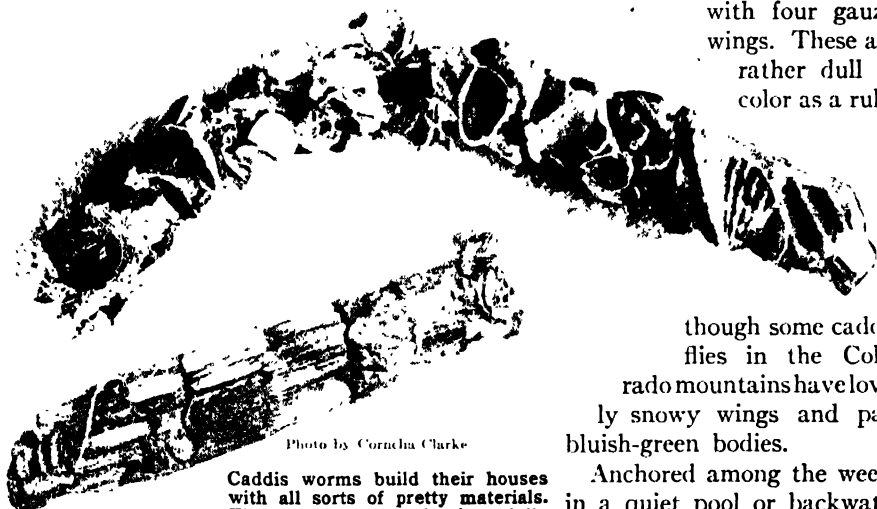
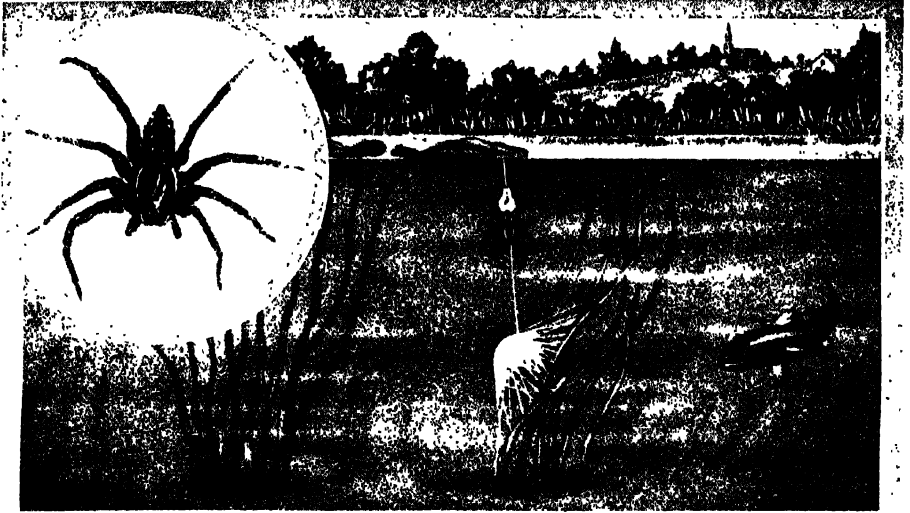


Photo by Cornelia Clarke

Caddis worms build their houses with all sorts of pretty materials. The upper one is made of carefully selected shells and pebbles, but the worm which made the lower one preferred a more rustic type of cottage, so he used bits of bark and wood.



How many hundreds of trips will our little water spider make up and down the swaying rope before she has carried down enough tiny air bubbles to fill her little house? Her hind legs are very slender, as you may

see from her picture in the upper left-hand corner; but with them she must capture her bubble of air. And her little water-proof bell must be of fair size, for in it she must stay all the winter.

—just as the wand of the fairy godmother changed Cinderella's kitchen rags to a beautiful ball dress.

This marvelous transformation is caused by the large quantities of tiny air bubbles which are entangled in the thick, soft hairs with which the body and all the eight legs of the spider are clothed. So as she moves beneath the water she is always surrounded by a silvery film of air.

## This Spider Lives in a Bubble

It is most thrilling to watch one of these little water folk making her house. She begins by weaving a tiny bell-shaped web, which she fastens securely with silken ropes to a plant well below the surface of the pond. At first her work does not appear at all shapely! It looks like nothing but a small, shadowy bundle in the water, and is not in the least silvery. But now the spider runs up a rope, which she has thoughtfully fixed to a floating leaf, and pushes the tip of her fairy body above the water line. With a quick little flick she catches a bubble of air and, holding it between her hind legs, down she goes again and pops it into her house.

The spider makes ever so many journeys to the top of the water, for it takes no end of bubbles to fill her house completely. Gradually, however, the filmy bundle takes shape like a balloon filled with gas—until at last it stands out clearly among the dark weeds like a silvery fairy bell. In this way the spider builds herself an airy chamber.

All through the summer the spider lives in her house, popping out now and again to catch a few water insects for dinner, or to make an excursion to the top of the water for a new diving dress. Then when winter comes she stays at home altogether, and goes to sleep until the weather grows warm again.

And so life goes on in the wonderful water world. The little bubbling stream as it hurries along on its journey to the sea has always something fresh to show us, some new tale to tell of the marvelous creatures, great and small, that live in its sparkling waters. There is so much to see, so much to learn about the *true* water folk, that if we do not meet with any of the nymphs and elves that haunted the streams—so they say—in olden days, we shall really have no time to miss them.



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# WONDERS of the INSECT WORLD

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## Reading Unit No. 13

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### WINGED DWELLERS IN POND AND STREAM

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How water insects spend the winter months, 3-396-97  
How the whirligig beetle lives, 3-397-98  
How the hungry diving beetle is equipped to hunt in water, 3-399-400

How the scavenger beetle keeps from drowning, 3-401  
How the giant water bug hunts and lives, 3-402  
Water boatmen and pond skaters, 3-403-4

#### *Things to Think About*

Where do water insects go during the winter?  
How can you recognize whirligigs on the water?  
What is the diet of a giant diving

beetle?  
How does the scavenger beetle replenish his air supply?  
How are the legs of a water boatman built?

#### *Picture Hunt*

What enables whirligigs to leave the water? 3-397  
Where do water scorpions lay their eggs? 3-398  
Why does the giant water beetle find it hard to walk on land? 3-400  
How does the scavenger beetle

protect her eggs? 3-401  
Why is it easy for the electric-light bug to pounce on his prey? 3-402  
What special changes have helped the water boatman? 3-403  
What water insect does not get its feet wet? 3-404

#### *Leisure-time Activities*

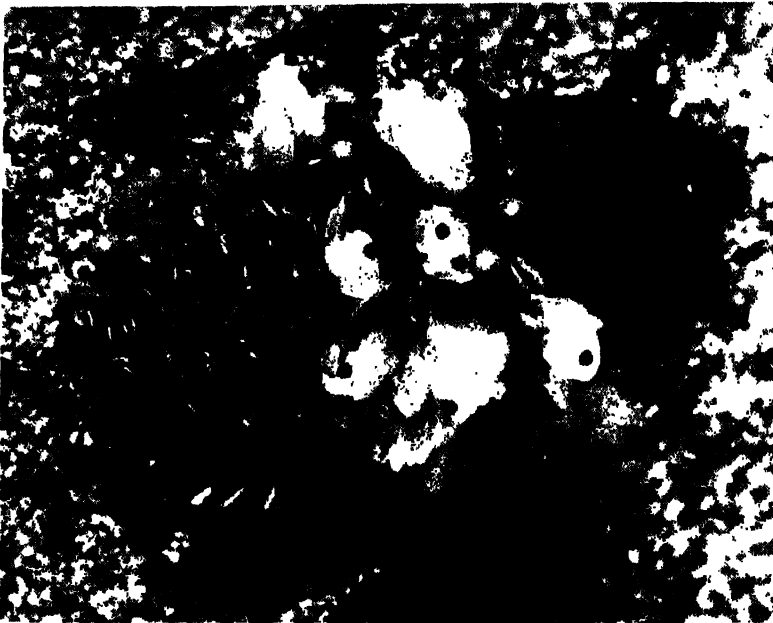
PROJECT NO. 1: Visit a pond in summer. How many water insects can you discover? If necessary, use a net to get insects that live on the bottom, and put them in a jar for examination, 3-396-404  
PROJECT NO. 2: Set up an aquarium at home, with some

water plants and fine gravel at the bottom. Using a net, collect live water insects from the mud and water. Put some mud and the water insects in your aquarium. You can learn a great deal by watching these insects, 3-396-404, 14-2-5.

#### *Summary Statement*

All water insects come to the surface for a little air. Their life in the water is full of danger, for

almost all insects are cannibals. Some insects even catch and eat fish, tadpoles, newts, and snails.



The strange-looking affair at the left is the giant water bug with his children's empty egg cases attached to his back. There his frivolous mate laid her eggs, at the same time sealing his wing covers so that he could not fly away until the eggs were hatched. So he patiently paddled about, holding the eggs up to the warmth of the sun and not having very much fun. But now his duties are nearly over. All but a few of the eggs have split and let out the young nymphs. The rest of the nymphs are just hatching—you can see their black eyes.

Photo by Lee Passmore

## WINGED DWELLERS *in* POND *and* STREAM

*Millions of Dainty Creatures Whirl and Buzz and Hum along the Brookside of a Summer's Day, and All of Them Have Had a Life So Strange that It Reads Like a Fairy Tale*

**I**F WE could take a census of all the water folk in a pond, we should find that the insect population far outnumbered all the other inhabitants.

Insects are to be found living contentedly in almost any kind of water. Some like clear water, others like stagnant pools and muddy ditches; some like the bustle and excitement of swift-running water; a few even enjoy the rush and tumble of cascades and mountain torrents; but most insects prefer a gentle, rippling stream or a sheltered backwater. And a quiet shallow pool covered with a soft green mantle of duckweed suits them best of all.

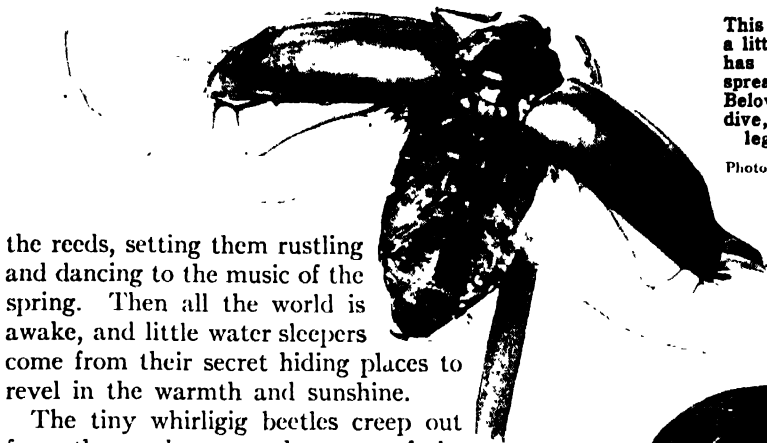
Water insects are not a special kind of insect. They belong to many different insect tribes and they all have relatives on land who would be drowned if they happened to fall into the water. There are water beetles, water bugs, and ever so many different water grubs. Some insects live all

their lives in the water. Others are merely water babies; the ponds and streams are their nurseries, where they spend their youthful days. When they are grown up they are changed from ugly, crawling grubs into bright-winged flies and leave the water world to dance in the sunlit air.

Insects are frail little creatures, and as soon as winter sets in most of them disappear. Many die, others seek winter quarters. Yet even on the coldest days a few of the hardest insect folk are to be seen going about their business as usual, regardless of the water's icy chill, which sends their less robust neighbors scurrying off to bed in the mud or thick tangles of weed.

All the year round there is sure to be something going on in the wonderful water world. But best of all is the springtime, when the banks are gay with golden kingcups and yellow flags, and the wind—like the magic pipe of Pan—whistles softly through

## WONDERS OF THE INSECT WORLD



This whirligig has decided to take a little spin through the air, so he has climbed a water reed and spread his wings, ready to take off. Below is another whirligig about to dive, for he has curled in all his legs except the two front ones.

Photo by Cornelia Clarke

the reeds, setting them rustling and dancing to the music of the spring. Then all the world is awake, and little water sleepers come from their secret hiding places to revel in the warmth and sunshine.

The tiny whirligig beetles creep out from the mud among the roots of the water weeds, where they have been sleeping the winter away. Up they come to the top of the water for a breath of fresh air. Then away they go, darting wildly to and fro and spinning round and round in a circle, as if they were dizzy to find themselves out and about in the world again.

### The Whirligig Cannot Walk

The whirligig is a smart little fellow. He is about a quarter of an inch long, and the stiff polished wing cases which cover his back are a deep blue-black. At first sight he appears to be very much like many another small beetle that you may meet running about on dry ground. But if you fish him out of the water you will find that the whirligig cannot run; he flops about in the most ridiculous way when he is deposited on the ground. His legs are really most extraordinary, but then, they are intended for swimming, not for taking walking exercise.

The last pair—for of course the whirligig has six legs, as all insects have—are the broad flat paddles,

fringed all round with long stiff hairs. The middle pair, too, are like paddles, but they



are not quite so broad. And the first pair are long and slender and have a number of little suckers near the tips.

With his hind legs the little beetle swims merrily round in the water, and with his front pair he clings fast to the weeds when he is tired of darting and whirling about.

### Breathing from a Bubble

Although he is a true water insect, the whirligig is an air breather like all the beetle tribe—no matter whether they live in or out of the water. So every time he dives he carries down with him a bubble of air between the tips of his wing cases; and there you can see it glittering like a tiny ball of

quicksilver as the little beetle whisks about below.

The whirligig's eyes are as remarkable as his legs.

He appears to

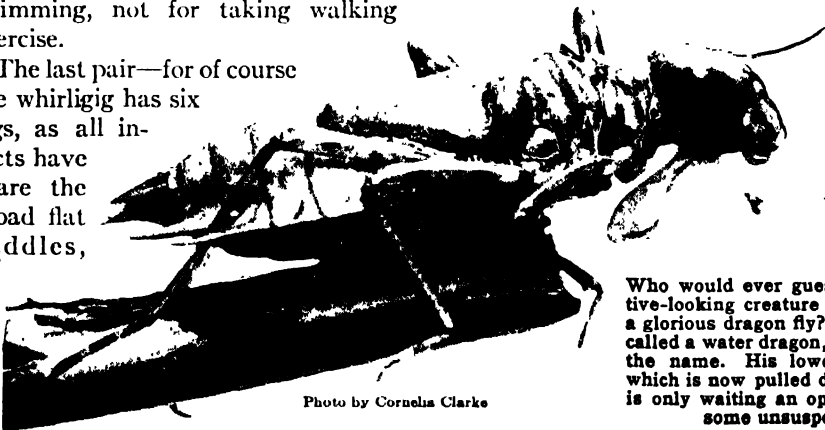


Photo by Cornelia Clarke

Who would ever guess that this unattractive-looking creature was going to become a glorious dragon fly? At this stage he is called a water dragon, and he well deserves the name. His lower jaw, or "mask," which is now pulled down under his chin, is only waiting an opportunity to snap on some unsuspecting insect.

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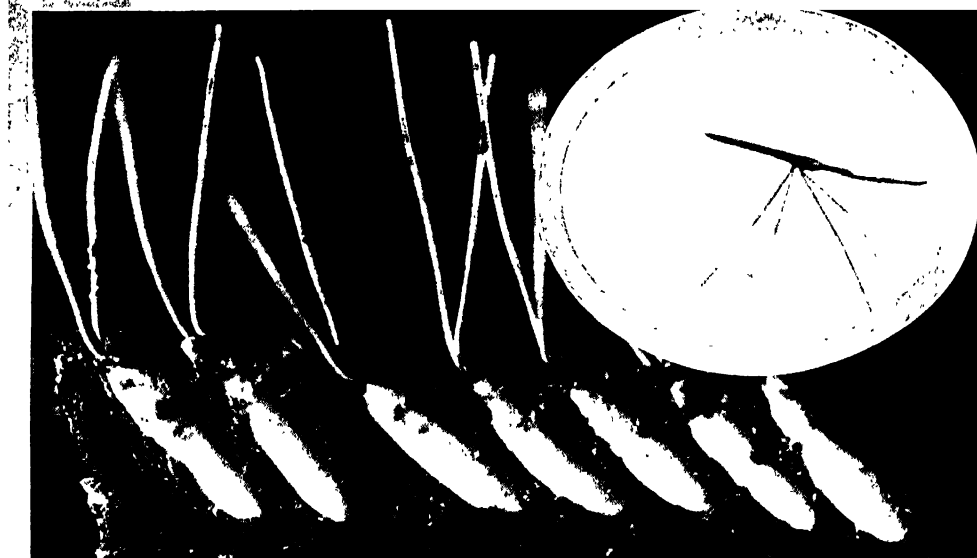


Photo by Cornelia Clarke

Part of the submerged stem in which they are imbedded has been removed so that you may see the babies of a water scorpion. It is hard to believe that

the strawlike little insect above is their mother. Notice the two waving ribbons, or filaments, that you see attached to the end of each egg.

have four eyes, but this is a delusion. He really has only two—tiny, round, compound eyes made up of hundreds of little lenses—but each eye is divided into two separate parts. So while the lower half is turned downward to scan the depths below, the upper half is gazing aloft to spy out what is going on above. It is by no means easy to catch the lively little gentleman unawares.

### How a Whirligig Flies

If his legs and his eyes are strange, there is nothing wrong with the whirligig's wings. He has a fine, gauzy pair neatly folded away under his wing cases, and he can fly very well, although he cannot take off from the water like a duck or a seaplane.

So when he is about to take a short excursion through the air, the little beetle has first to climb up a plant stem until he is well above the surface. There he sits and rests a while, gazing up and down and all around with his queer double eyes. Then, with a little squeak of excitement, the whirligig unfolds his wings, launches himself into the air—and away he goes, humming like a bee!

Early in the springtime there are only a

few of these funny little beetles about, but before very long we can see numbers of the tiny creatures, looking like small centipedes running and skipping around in the mud. These are baby whirligigs, the children of those beetles that have lived through the winter. They grow very quickly, and by the time summer has arrived the queer little grubs will have changed into beetles, and swarms of whirligigs will be whisking together in a merry-go-round all up and down the stream.

### The Fiercest Beetle in the Pond

They are harmless little creatures, these whirligigs, but if you succeed in catching one it will be very much annoyed and will express its displeasure by squirting a milky fluid, with a most unpleasant smell, from every joint in its small body over your fingers. So it is just as well to leave the little beetles undisturbed in their own water world. There they spend the sunny hours in dancing and in snapping up the tiny winged insects that fall upon the surface of the water. And sometimes the whirligigs get snapped up themselves by a big member of their own tribe. He is called the great diving beetle,

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and is a terror to all the small inhabitants of the water.

In comparison with the little whirligigs the great diving beetle is a real giant. He measures one and a half inches, and although not quite the largest, he is the most ferocious beetle to be met in pond or stream.

He is certainly a fine-looking fellow. His coat of darkest brown or olive is highly polished, his jaws are strong, his eyes are big, and his wrists are adorned with a handsome pair of frills.

He is highly accomplished, too. He can walk or climb or swim or fly, just as he pleases. His hind legs are long and flat with a fringe of stiff hairs all down one side; these are used as oars when the beetle is swimming, and he "feathers his oars" in a way that the most expert oarsman might envy. His second pair are his walking legs; they are stouter and shorter and end in strong hooked claws. And his two front legs are distinguished by having large frills round the wrists, covered with little suckers.

### Diver Beetles Fear No Foe

These frilly affairs are used for claspings and holding fast many a slippery insect that struggles in vain to escape from the diver's grasp. Well equipped in every way, the diver beetle fears no foe. He is a mighty hunter and a desperate fighter. He kills and devours tadpoles, snails, worms, newts, small fishes, and water insects of all descriptions. Should he meet a brother beetle, the two are almost sure to fight; they attack each other savagely with their great strong jaws, and when the battle is over, the victor proceeds to eat up his vanquished foe!

In the evening the diver is fond of taking a trip through the air. Sometimes he flies from one pool to another, where he continues his fearsome ways. In spite of his great

eyes, the beetle is somewhat shortsighted, and has been known to mistake the glittering glass roof of a hothouse for another pond and come down with a thud on the top of it. And this, of course, is the end of the careless fellow.

In its youthful days this diving beetle is just as savage and masterful in its ways. It is called a water tiger, and is an ugly, ill-conditioned young grub, with a thick, clumsy

body tapering toward the head and tail. Its head is large and flat, its legs are long and spidery, and it is armed with a truly appalling pair of big, sickle-shaped jaws. These deadly weapons are hollow, and at the tip of each fang is a small round hole through which the creature sucks the juices of its prey.

Well is this beetle grub called a "tiger," for it spends its days killing and devouring every small water creature that comes in its way.

It drags the worms from the mud and the snails from their shells; it clutches the insect folk with its hooked feet and, curving its body like a snake, it springs at the minnows and sticklebacks, as they swim peacefully by, and seizes them in its cruel jaws.

### Wiles of the Tiger Grub

There is no end to the wiles of the fierce water tiger. Sometimes it rows itself slowly through the water, twisting its head this way and that as it keeps a sharp lookout for victims. Sometimes it creeps stealthily over the mud. Sometimes it hides among the thickets of weed below the water, like a real tiger in his lair, and pounces out to seize any unfortunate little creature that passes near. It is very quarrelsome, too. If it meets one of its own relatives it is certain to start a fight. The big grubs spring at each other, seize each other with their jaws, and roll over and over together, struggling



Photo by Cornelia Clarke

It is sometimes as well to keep out of the mud, particularly if there are any leeches about. Certain of the unlovely creatures get their meals so quietly that you do not even know they are there until you feel a little trickle of warm blood.

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and biting for all they are worth until one is killed. Then the conquering hero eats its foe.

At the end of its tail the water tiger has two queer little tubes, and when it needs a whiff of fresh air it rises tail first to the top of the water and pushes its tubes through the surface film. Then, having refreshed itself in this way, it goes down again to continue its marauding ways.

So the water tiger lives and grows beneath the water until it is quite two inches long. It is now full-grown. At last comes a day when it seems to feel restless. It no longer cares to hunt or fight; even its appetite fails. So it creeps out of the water, and scoops out a little round cell in the damp earth on the bank of the pond or stream. There it changes into a strange mummylike thing called a pupa (pū'pā), and in this state it takes a long, quiet rest.

If it is summer time, the insect stays for three weeks or so in its solitary cell; but if it does not turn to a pupa before the autumn, it will not leave its secret hiding place until the following spring. When it does come out, it is neither a water tiger nor a pupa, but a noble diver beetle, with a polished coat, six fine legs of various kinds, and a splendid pair of gauzy wings all ready to fly with.

This great beetle has many close relatives. Most of them are a good deal smaller than he is, but otherwise all the divers look and behave much alike. You may always recognize one of the family by the frills on its front legs. That is to say, you may know the male diver beetles by this peculiar adornment; the females of the species are not so big as

their mates and never wear frills. Some lady divers just drop their eggs in the water in the most careless manner; others push them into slits in stems of water plants and take no further trouble about them.

In many a quiet stream or weedy pool we may find the great water scavenger (skāv'ën-jēr) at home. He enjoys the proud distinction of being the largest beetle inhabiting the water world. But although he is quite a quarter of an inch longer, he is no match for the quarrelsome diver.

In spite of his size the water scavenger is a placid, harmless creature; he is just a rather dull, mild-tempered giant. He does not want to fight or bully his small neighbors; he only wants to be let alone and allowed to go his own way in peace. As a matter of fact, the big beetle is not fitted for a warlike career, and has little power of defending himself against the attacks of the bold diver beetles and other savage creatures in the pool. In a swimming contest, too, the diver would beat him every time, for the scavenger's legs are not nearly so strong as his rival's and he moves slowly through the water in a curious jerky way. To be sure, the big beetle will devour

very small water creatures when they come his way, but he is largely a vegetarian, content with a diet of leaves and grasses; or he will feed on any decaying material he finds in the water. This, of course, is why he is called a scavenger—or garbage man.



Photo by Cornelia Clarke

This giant water beetle would feel most abused if you were to put him on dry land, for his legs are built like oars and are meant, naturally, for swimming and not for walking. Even in the water he is not so active as his cousin, the diving beetle; nor is he so much to be feared by all the smaller water folk, in spite of his great size.

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But the lazy giant is a handsome fellow. His shining coat of olive green is so dark that it looks quite black in the water, and as he swims slowly about, he appears to be wearing a breastplate and a collar of glittering silver. This charming effect is produced by a thin film of air which spreads over the under side and round the neck of the beetle. On his back, too, he carries a supply of air, but this we cannot see, for it is concealed by his wing cases.

When he wants to renew his air supply the water scavenger rises to the surface head first. Then turning over on one side, he bends his head to open a little cleft between the head and shoulders; at the same time he curves one of his feelers backward to form a little funnel through which air is sucked down. The air spreads in a silvery layer over a large part of his body, and so the scavenger may be said to be clothed in air. Of course the diver beetle carries a supply of air about with him too, when he is under water, but he keeps the air in an air tank along his back, and we only catch a glimpse of the silvery bubble between the tips of his wing cases.

### Bold Children of the Scavenger

Although the scavenger is a poor swimmer, he has a strong pair of wings and can fly very well. He often leaves the water at night for a little exercise in the open air, and you may frequently see him, sometimes in company with a diver beetle, circling wildly around an electric lamp. This escapade usually ends in disaster.

Now one would naturally suppose that the children of these quiet and, as a rule, well-behaved water beetles would be quiet and well-behaved too. But no such thing!

The baby scavenger beetles are bold, fierce grubs, almost as savage in their ways as the water tigers. They kill and eat all the small water folk they can catch and think nothing of making a meal of one of their own brothers or sisters if other game happens to be scarce. They are not handsome either. When full-grown they are fat, clumsy grubs three

inches long, with soft sooty-colored bodies and hard shiny heads and shoulders of reddish brown. They are not so quick and active as the water tigers, and they have a funny habit, whether they are resting or crawling about, of turning up their heads and tails. It makes them look a little like small sausages.

These strange grubs start life in a most charming and clever little ark, which floats upon the surface of the water. It is like a tiny silken casket with a mast at one end to keep it steady. It is made by the mother scavenger

with silk from the little spinning machine she has at the end of her body—just as the spider has.

This dainty craft is designed as a cradle for the babies, and when a mother scavenger has placed fifty or sixty tiny pointed eggs inside it, she carefully closes it before adding the little mast as a finishing touch.

Some beetles anchor their egg cocoons with a silken rope to the water plants; others set them adrift to float like fairy arks upon the face of the water. They are filled with air and perfectly water-tight, and so well balanced that they never capsize. For three weeks these tiny arks drift about, and then the eggs hatch. The young grubs bite through the silken walls with their sharp little jaws and slip out into the water.

Bigger than the great water scavenger and every bit as savage as the diver beetle is the



Photo by Cornelia Clarke

Here is an enlarged view of a female scavenger's floating cradle filled with eggs. It is made of silk threads.

Sixty little "Moseses" in the bulrushes! These tiny eggs do not need an Egyptian princess, however, to take care of them, for they will float safely over the water until they are quite able to take care of themselves.

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giant water bug—or the electric-light bug, as it is often called. Maybe you have seen one of these huge insects on a still, sultry midsummer evening, whirling round and round a street lamp in company with swarms of smaller insects that have been attracted by the bright light. But perhaps you did not know that the odd-looking fellow that dances so wildly, and occasionally bumps into the lamp and tumbles plump to the ground, is really a water insect and has no business to be abroad in the town at all.

This great bug is really a giant among all the other insect folk in pond or stream. He is no less than two and three-quarters inches long and one and a quarter wide. He has a queer flat body, broad flat legs which make capital oars, and instead of a pair of cutting jaws, such as beetles have, he is armed with a sharp, short beak, with which he stabs the victims he is always on the lookout for.

This ogrelike monster swims slowly about at or near the bottom of the water, with his two front legs held out in front of him all ready to clutch any unfortunate little creatures that may come within his reach. Sometimes he hides beneath a stone or a tangled mass of weed and darts suddenly out on his prey. He captures small fishes, tadpoles, and water insects of all descriptions, stabs them with his beak, and sucks their blood.

### How to Tell a True Bug

The giant bug has many relatives in the water world, though not one of them can compare with the ogre in size. But they are all, big or small, armed with the same kind of sucking beak, for this is the distinguishing feature of all true bugs.

Creeping over the bottom of the pool goes

the water scorpion, a strange-looking creature that appears to have only two pairs of legs, for as he moves slowly along he holds up his first pair as a crab does its claws, all ready to seize his prey the moment it is within clutching distance. Very curious these legs are. The shank and foot fold back into a groove in the broad thigh of the insect, just as the blade of a clasp knife shuts into its handle. Once caught in this terrible trap the small victim struggles in vain to escape; it is held fast until it has been sucked dry by the scorpion's piercing beak.

There are two water scorpions,

The electric-light bug, which you see here, with and without his wings spread, is a very vicious animal. He will lie in wait for his victims near the bottom of the water, looking just like a dead leaf, and will suddenly dart out and clutch them with his knifelike front feet.

Photo by  
Cornelia  
Clarke

both alike in their ways but so unlike in appearance that you would never think they could be members of the same insect family. One is broad and flat, and one is so long and thin that it might be a wisp of straw with six spidery legs attached to it. But they both have the same queer forelegs and piercing beaks, and both have two long bristles at the tail end of their bodies. These the insects fit together to





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form a tube and push through the surface film of the water to take in their supplies of fresh air. Water scorpions are lazy creatures; they do not move about very much, but like best to lie half buried in the mud and rubbish under the water and grab poor little water folk as they pass by.

While the water scorpions skulk below in the mud, the lively little water boatmen—or back swimmers—all sport themselves gayly in the water overhead. They, too, belong to the bug tribe of the insect world, as you can see at once by their sharp beaks. If you scoop one of these little creatures from the water, you may find its beak, too, for it will be likely to give your finger a smart dig for your pains.

A water boatman is quite as savage as a water scorpion, but instead of lying in wait for his prey, he furiously chases the smaller water creatures all up and down the stream—or round and round the pond, as the case may be. Although he is very small he is very courageous; a boatman less than a quarter of an inch long will boldly attack, and even kill, an insect twice his own size.

This odd little bug is exactly like a boat in shape—flat below and rounded like the bottom of a boat above. So he turns himself over on his back and rows himself energetically about with his

long hind legs, like a tiny, living rowboat.

He is really a smart little fellow in every way. Under his wings he wears a close-fitting velvety suit, overspread with a glittering film of air. This makes the boatman so buoyant that he bobs about like a cork. When he is under water he is

obliged to hold tight to the weeds to keep himself down, for as soon as he lets go, he shoots up to the top again.

When he is excited, especially in the evening, the

water boatman sometimes makes a queer little noise which sounds like “chew-chew-chew.” He does this by rubbing his hands together—or perhaps we should say his forefeet.

Another water bug, also called a water boatman, is said to play a tune by drumming on his snout with his front legs. It seems a curious trick, but since many insects do make sounds, and since his own cousin goes “chew-chew-chew,” there seems to be no real reason why the little water boatman should not beat the drum. He, too, has a boat-shaped body, but he swims back upward in the usual way; and since he is not so completely clothed with air, he has no difficulty in remaining under water if he feels inclined to do so.

Skimming over the top of almost any pond or quiet pool where a little stream rests a while before hurrying on its way, we are sure to see some of those strange insects we call water striders

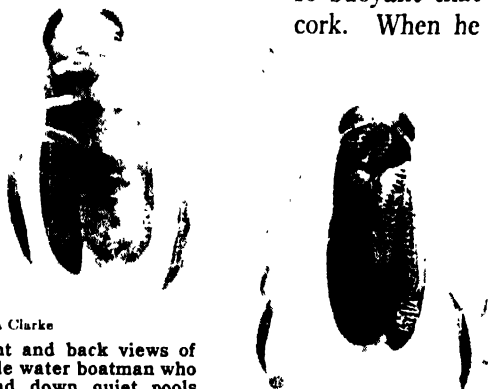


Photo by Cornelia Clarke

Here are front and back views of the sturdy little water boatman who chases up and down quiet pools looking for smaller insects to munch on. He moves very rapidly, for he is covered with air bubbles and has very strong rowing feet.

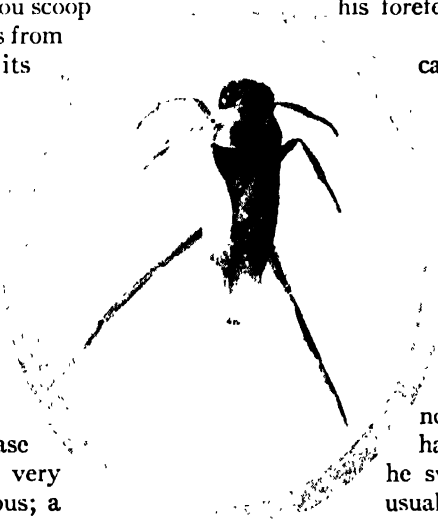


Photo by Cornelia Clarke

The water boatman is sometimes called a “back swimmer,” for, being flat on top and rounded beneath, he always swims on his back.

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or pond skaters. Some have small button-like bodies, some are flat and oval, and others are so thin that they look like wisps of straw or bits of thread. But one and all have sharp, piercing beaks and absurdly long spidery legs on which they skate and slide and run and leap with the greatest ease upon the surface of the water. These queer bugs—for bugs they are—are such light and airy things that they never sink down into the water, but as they run their little feet make tiny dimples in the surface film, which on a sunny day cast dancing shadows on the sandy bottom of a clear, shallow pool.

Pond skaters are rather timid folk. They do not care to attack vigorous insects, but live chiefly by sucking the blood of small dead or dying creatures that fall upon the water or float up to the surface from below. When they are not gliding about looking for something to eat, the skaters are usually

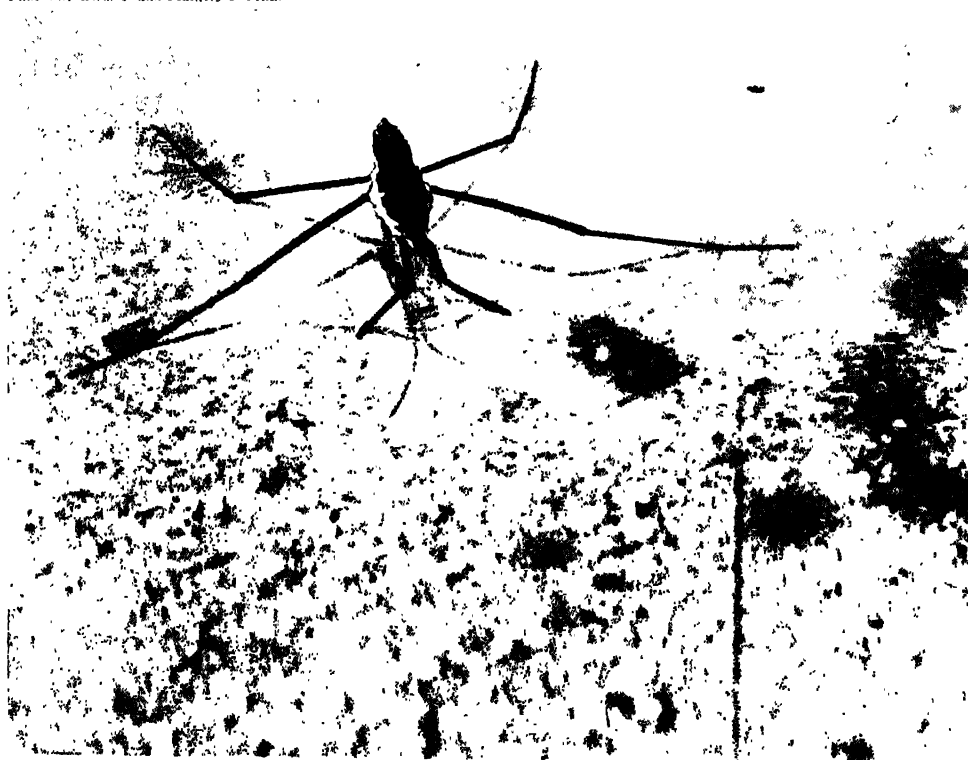
occupied with their toilet. Their heads, their bodies, and even their long thin legs are clothed with a short velvety pile which they are always cleaning and brushing. Most of these insects prefer to stay on the top of the water, but some will occasionally dive below carrying air bubbles at the end of their tails; and then their short velvet coats keep them quite dry and comfortable. One of these long-legged bugs is in the water quite as much as he is out of it, and may often be seen walking over the under side of the surface film, just as a fly walks on the ceiling.

Although they look so frail the little water skaters are really very hardy insects. Even in the winter, if the ponds are not frozen over, you may see some of them skimming about on the water. Some, too, are able to fly, though water skaters never have wings until they are quite grown up.

How often, in the quiet stillness of a summer's day, have you lain beside a sunlit pool and watched the "skippers" darting over its surface without ever wetting their feet? You would swear it could never happen if

you had not seen it. Our picture shows clearly the wrinkles that come from the strain of that tiny weight on the surface of the water. In the background are the pebbles at the bottom of the pool.

Photos by Lotus J. and Margery J. Milne



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# SPIDERS *and* THEIR KIN

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## Reading Unit No. 1

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### SPIDERS AND THEIR KIN

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How to distinguish between spiders and insects, 3-406  
The perilous courtships of male spiders, 3-407-9  
How a spider weaves its web, 3-408-9

How mother spiders care for their young, 3-409-11  
Jumping and hunting spiders, 3-411  
Poisonous scorpions, 3-413  
Mites and ticks, 3-413

#### *Things to Think About*

How is a spider made?  
How does an orb weaver build its web?  
How have some spiders been dis-

tributed all over the world?  
What damage is done by mites and ticks?

#### *Picture Hunt*

What care does the wolf spider give its young? 3-406  
Why must the hunting spider go after its food? 3-407  
What steps do orb weavers follow in weaving a web? 3-408  
What poisonous spider is shipped

with bananas? 3-410  
When do garden spiders hatch from eggs? 3-410  
Where do scorpions live? 3-411  
Why do wasps often attack spiders? 3-412

#### *Related Material*

Why are some monkeys called spider monkeys? 4-262-63  
Why is the king crab not classified as a crab? 3-190-92

What crab has begun to look like a spider? 3-183  
How has one spider adapted itself to life in the water? 3-394

#### *Leisure-time Activities*

PROJECT NO. 1: Place a spider's web between two square sheets of clean window glass for study and exhibition, 3-408.

PROJECT NO. 2: Observe spiders working and feeding, 3-408-9.

#### *Summary Statement*

Spiders have eight legs, a joined head and chest, and silk glands at the end of the abdomen. Spiders' beautiful silk webs are designed to catch unwary insects.

Mites and ticks are cousins of the spider and may cause serious harm to man and domesticated animals.

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## SPIDERS AND THEIR KIN

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This fierce-looking creature is a *Lycosa*, or wolf spider, with her egg sac. When the little spiders hatch out they will climb on their mother's back and cling to her for weeks before striking out for themselves.



Photo by Cornelia Clarke

## SPIDERS *and* THEIR KIN

*The Clever Little Weaver Who Strings Her Web Together under Your Very Eyes Is Full of Tricks and Amazing Ways Which You May Read of Here*

**W**ILL you walk into my parlor?" said the spider to the fly. And the particular spider in question was by no means the only one that has asked the question. For the spiders spend a good share of their time inviting flies to walk into their parlors, or webs. Once the invitation is accepted, the unhappy guests find that they cannot walk out again, and are quickly killed and devoured.

Now first of all you must clearly understand that a spider is not an insect. It really is not at all like one, as you will see when you look at it carefully. A winged insect has six legs, and its body is divided into three distinct parts—head, chest or thorax, and hind body or abdomen. Now look at a spider; and first of all count its legs. You will find there are eight of them. That number holds good for all spiders and their kin—the harvest mites, the ticks, and the scorpions. Next, see how the head and chest are fused together; in fact, but for the jaws and a curious pair of feelers called "palps," you might almost think that a spider had no head. There are no large compound eyes, one on each side of the

head, such as a fly has. There are only a varying number of very small, beadlike, simple eyes arranged in two rows on the top of the head. The queer "head chest" is joined to the spider's hind body—which is usually somewhat round and plump—by a very short, narrow waist; and on the end of the body you can see—if the spider is a fairly big one—several little swellings or rounded knobs. These are the silk glands, or spinnerets, from which the spider weaves her web.

Then, too, a spider does not pass through a series of transformations, as an insect does. A spider is always a spider, never a grub or a caterpillar. When it first hatches out of its egg, though it is only a speck of a thing, it is nevertheless a very tiny edition of its parent, and if it is a spinner, it will very soon weave a few strands of web, like a grown-up spider, in which to catch an unwary midge or two for dinner. As the little creature grows, it casts its skin, or moults, several times; and on each occasion it increases in size; but it does not change in shape.

Spiders vary enormously both in size and habit, ranging from delicate little creatures

## SPIDERS AND THEIR KIN



Photo by Cornelia Clarke

Here is a jumping spider with its victim. Jumping spiders are of medium size with short body and short, stout legs. They are black, with colored spots, and have conspicuous green eyes. You may find them on

plants, around logs, and along the sides of buildings. They make no webs, but live in nests and stalk their prey, advancing with quick, jumping movements in any direction and pouncing like lightning on their victims.

scarcely a quarter of an inch in length to great tropical spiders with a twelve-inch span between their long, hairy legs. Some spiders build the most complicated and beautiful webs, often of geometrical design, while others are content with much simpler snares; some make tunnel-like nests in the ground, lined with softest silk and closed by wonderfully-made trapdoors; others again lead a roving existence, making no web but hunting down and leaping upon their prey. Some are clad in brilliant colors, living jewels of the spider world, while others are dressed in more sober hues.

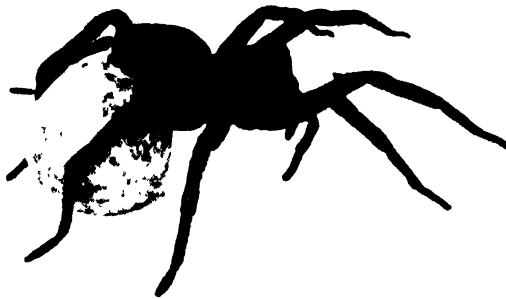


Photo by Cornelia Clarke

Here we have a female spider with her egg sac. It takes a day or two for a cocoonful of young spiders to hatch out. Then for a few days more the baby spider is a pale, weak thing. After that, however, if it has not been destroyed by some of its many enemies, it crawls out of the skin it was hatched in and steps from the cocoon into the world.

Many male spiders indulge in the most astonishing dances and antics during courtship, a business that is nearly always fraught with considerable danger, as female spiders, for the most part, are of uncertain temper and bloodthirsty. If the advances of the male do not quite please the lady he is wooing, she will pounce upon him and gobble him up! Even after he has been accepted as a mate, the male spider's life is not altogether a happy one, for his wife in a sudden fit of temper may turn upon him and slay him. So courtship and marriage in spiderland is apt

## SPIDERS AND THEIR KIN



Photo by American Museum of Natural History

Here are the stages by which the orb-weaving spider spins her lacy web. First she lays side threads from twig to twig of her support, and then threads radiating from the center like the spokes of a wheel. Next she starts from the center and works out in a spiral,

strengthening the web and holding the spokes in place. Then she starts from the outside and works inward, laying the sticky, fine thread that will ensnare the flies. As she works back to the center she destroys the old foundation spiral when it is in her way.

to be a perilous adventure for the male spider, though on the other hand, there are a few species which appear to be more peaceably disposed toward each other.

Male spiders are nearly always smaller and more active than the females, though their legs are longer. They may be distinguished by the curious swellings which all male spiders have on their palps, or feelers.

Spiders such as the "orb weavers" have tiny combs on the ends of their legs instead of simple claws. These are used for carding and guiding the silken threads as they issue from the spinnerets. When a big common garden spider starts

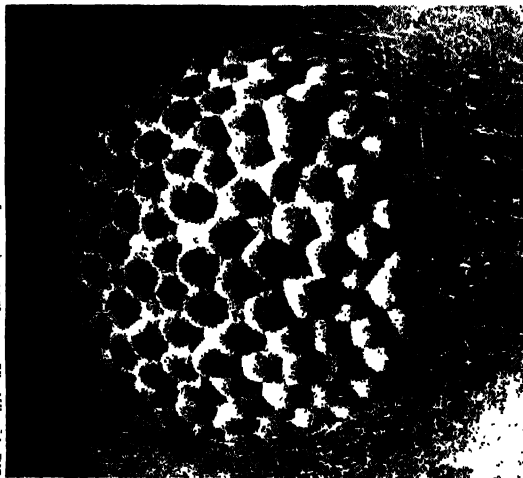


Photo by Cornelia Clarke

Spiders always cover their balls of eggs with a silken cocoon. Such an egg ball as this one of the shamrock spider is colored yellow or orange. The shamrock spider is one of the orb weavers, and gets its name from the fact that some of the species bear a mark that looks rather like a shamrock. The egg ball is about half an inch in diameter, and a hundred little spiders, more or less, will crawl out of it.

weaving her beautiful web, she first lays down a series of foundation lines, stretching from one point to another. These are very strong, and firmly attached at each point where they connect with a twig. All this is very necessary, for those threads have to carry the whole weight of the web,

and to withstand the violent strain set up by gusts of wind and the struggles of large captured insects. Having fixed the foundation boundary lines, the spider next weaves

a series of radiating threads that look like the spokes in a cart wheel. When this has been accomplished, she proceeds, starting from the center of the web where all the spokes meet, to weave a wide spiral thread which connects all the spokes.

Up to this point the spider has only used firm dry threads, which would not seriously entangle any insect that might fly against them. Now, however, she begins to weave a second spiral thread in the spaces left between

the first spiral, and for this she uses a very fine and elastic thread coated with a sticky, gummy secretion. Starting at the outer edge of her web she holds on to the foundation lines with her front legs, while with the comblike claws on her hind legs she draws the gummy thread from her spin-

## SPIDERS AND THEIR KIN

nerets, holding it firmly so that it may stretch. As she fixes it to each radiating spoke, she lets it go with a sudden snap which causes a series of little blobs of the sticky coating to form all along the line, like a row of tiny beads. It is this sticky beaded spiral line that holds fast any unfortunate insect that blunders into the web. Should the insect only touch it with a tip of a wing, the creature is held fast, and the more it struggles to free itself the more entangled it becomes.

The American orb weaver adds a broad ribbon of flossy silk to her web, worked in a zigzag pattern between two of the spokes of her wheel; and right in the center she lays down a small, closely-woven carpet on which she takes her stand while she waits for her dinner.

The small triangle spider, which is quite common in the pine woods of many parts of North America, weaves a triangular web which is really a most clever spring trap. Two points of the triangle are fastened to twigs. To the third point the spider fixes a stout and fairly long cord, the other end of which she fastens firmly to another twig a little distance away.

On this cord the spider takes her stand, clinging to her rope with all her eight legs. The clever little spinner pulls the rope in so that it is quite taut, and coils the slack part of the coil between her front and hind legs.

When the shaking of the cord tells her that some insect has flown into her trap, she lets the rope go and her victim is at once

entangled in the meshes of the loosened web. The spokes of the wheel are not sticky, but are all fluffed out by the combs on the hind legs of the cute little weaver; this makes escape from them more difficult.

Young spiders are great aviators. On quiet, almost windless mornings in late

summer and early autumn, you may see the tiny creatures standing on the topmost sprays of the hedgerows, on the top of fences, or on any similar vantage point, making ready for flight. Standing high on its front legs, the little baby spider faces the wind and draws out from her spinnerets a fine silken ribbon which is wafted out in the breeze. When by the pulling of the silken threads she feels that they are long enough and strong enough to carry her safely through the air, she grasps the ends of the threads with her legs and sails away on a voyage of discovery. In this way

spiders are carried long distances from their original home. Sometimes they are blown far out to sea; and if, as sometimes happens, their threads catch in the rigging of ships, they are transported far away to other lands. There is one tropical spider that has been distributed completely round the globe by the aid of the trade winds and the ships, which together have carried her from island to island and from continent to continent.

The female spider may not be altogether an ideal wife, on account of her uncertain temper and a cannibalistic tendency to devour her husband; but she is a most devoted



Photo by Cornelia Clarke

Here we have caught a garden spider—one of the orb weavers—in the very act of spinning her web. She will spend an hour or two doing it; it will probably be destroyed during the day, and to-morrow she will build it over again. Old spiders like to spin at night; but one may often catch young spiders at work when there is plenty of daylight by which to watch their clever craftsmanship.

## SPIDERS AND THEIR KIN



Photos by Cornelia Clarke

This hairy fellow is a tarantula—one of the Mygale spiders—who has shipped in from the Tropics on a bunch of bananas. He is a very unwelcome guest,



for not only is he large and ugly, but he has a poisonous bite. It is always possible to tell a Mygale spider by his hairy legs and his hard, shining poison fangs.



Photos by Cornelia Clarke

Above left is the egg sac of the common garden spider. Sometime in May several hundred little spiders will hatch in this sac. As there is nothing else to eat,

mother, and often forms a beautiful silken receptacle for the protection of her eggs and young. These silken nests, or cocoons (kō-kōon'), vary in size, shape, and color according to the species of spider. Some



they will feed on each other until there are considerably fewer. At the right is the cunningly contrived nest of a California trapdoor spider.

are like balls of fluffy silk, some like fairy hammocks, others are shaped like peaked caps, pie dishes, or fairy lamps; and some are trimmed with silk embroidery or decorated with tiny pieces of leaves and flower petals.



## SPIDERS AND THEIR KIN

Some spiders actually attach the cocoon to their bodies and carry it about with them until the baby spiderkins have all hatched out and departed; others hang their little nests up in a corner of their web, or attach them to a grass stem, or hide them under leaves or stones, or in cracks in the bark of trees.

The sheet-weaving spiders make a closely woven web almost like the finest silken muslin. When first made it is a very beautiful thing, but its snowy whiteness soon grows soiled and dirty-looking and it becomes the familiar grayish cobweb that we see hanging in the corners of deserted rooms and old out-buildings. The hairy, long-legged 'house spider' belongs to this group.

The trapdoor spider lives in a tubular burrow underground, which she excavates with the help of her strong jaws. Having dug out the shaft to a suitable depth, she lines the walls with silk so that the particles of earth are held together and the sides cannot fall in upon her. She then proceeds to make a wonderful circular trapdoor, composed of sheets of silk with layers of earth between them. Patiently she adds layer after layer until a thick, solid lid with a stout silken hinge has been formed. Grains of earth, tiny stones, and even pieces of twigs, leaves, and moss are fastened to the outside of the lid, so that when it is closed it is almost impossible to distinguish it from the surrounding ground. Inside the nest is thickly lined with silk.

When the spider is at home she usually sits near her trapdoor, and will hold on to its silken lining firmly to keep it tightly closed should any unwelcome visitor try to enter. At night she comes forth to hunt her prey. Some species hunt down their victims, while

others spin a snare close to the ground at a little distance from the nest, seizing any insect that blunders into the web and carrying it off to the nest where it can be devoured at leisure. With the return of daylight this primitive snare is nearly always destroyed and cleared away by the spider before she retires to her nest to rest.

The jumping spiders are small, keen hunters that love warmth and sunshine. They may be seen in the summer time actively running over the ground or up and down sunny garden walls and fences. They stealthily stalk their prey, as a cat does, and pounce suddenly upon the unsuspecting insect. The little males are often brilliantly colored and adorned with remarkable bristles and plumes. When playing court to the female they indulge in the most extraordinary posturings, leg-wavings, and dances to show off their brilliant colors to full advantage.

In the Tropics the hairy *Mygale* (mīg'ā-lē), or hunting spiders, attain a great size, their stout hairy legs sometimes covering a span of eight or ten inches. The hairs that clothe the stout

body and legs are often far more dangerous to human beings than is the bite of this giant spider, for they are very fine, sharp-pointed, and brittle, readily piercing the skin and setting up a painful and irritating swelling. It is in tropical America that these spiders reach their greatest size. They prey upon large insects and are said occasionally to suck the blood of small birds that may have become entangled in their thick curtain webs.

Quite a number of smallish spiders resemble ants and other insects in shape and color, or they look like seeds or the buds of



Photo by American Museum of Natural History

This creature is a close kinsman of the spiders. He is an African scorpion, shown about three-fourths his natural size. Scorpions live only in warm climates.

## SPIDERS AND THEIR KIN



Photos by Cornelia Clarke

This fat creature is a typical orb weaver, one of the clever spinners whose wheel-like webs gleam in the morning sun in our fields and gardens.



This is the head of a *Lycosa*, or wolf spider, enlarged twelve times so as to show her eight eyes. No spider has more than twelve eyes.

flowers. In this disguise they are the better able to capture their prey.

The scorpion is a strange, forbidding-looking creature with its great pincer claws, slender body, and long, jointed tail which ends in a formidable curved, sharp-pointed sting. Like the spider the scorpion has eight legs, while its head and body are so closely united that it appears to have no head at all and the great pincer claws look as if they grew out from its shoulders. These claws are not really a fifth



Photo by Cornelia Clarke

Certain kinds of wasps feed their babies on fresh spider meat. This wasp has rendered the big spider unconscious with one thrust of her rapier, and now she is dragging him down the walk toward her nest.

pair of legs, as one might suppose, but a strange development of certain parts of the head. They are designed for seizing insects and bringing them within reach of the scorpion's complicated mouth. The small beadlike eyes are arranged on a ridge on the front of the head, and there is generally an extra pair on the center of the creature's back, or thorax, as it is called.

Although they are essentially tropical

creatures scorpions hate the great heat and glare of the noontide sun, and prefer to rest in some sheltered cranny under a rock or fallen log until night approaches. Then they wander forth in search of prey, holding their great pincer claws straight out in front of them and curving their long tails over their backs. Small insects when captured

are held and crushed in the great claws, the powerful sting being held in reserve for killing large strong insects which threaten by their violent

struggles to escape from their captor's claws. Then the scorpion swings its long tail over its back, and the sharp point of the sting is thrust into the victim's body. Near the point of the sting there is a tiny opening through which the poison from the big poison glands at the base of the sting is expelled into the wound. The unfortunate insect soon ceases to struggle. The poison from a large scorpion will

## SPIDERS AND THEIR KIN

kill a mouse or a rat outright and can cause very serious illness to a human being.

Scorpions vary considerably in size. Many smaller species are only an inch and a half or two inches long, while the great African and Indian species are most formidable-looking creatures.

### When a Scorpion Goes Courting

The male scorpion is usually smaller than his mate, and, like the spider, is in much danger when he goes courting. At first he stands facing the lady of his choice and bows to her politely. Should she be in a good humor she returns his bow, and the pair approach each other, curve their tails over their backs, and twine them affectionately together. Seeing that the lady is peaceably disposed toward him, the male scorpion clasps both her claws in his own, and proceeds solemnly to walk backward, while his partner slowly follows him. Thus hand in hand, the two peculiar creatures promenade up and down for an hour or more before they disappear from view into a burrow which the male scorpion has prepared under a flat stone.

If, after some time has passed, you raise the stone, you will probably find only one

scorpion at home. This will be the larger of the two. For if the lady scorpion grows tired of the company of her husband, she simply kills and eats him!

Mites for the most part are very small and active members of the spider family, so small that a pocket magnifying glass is often necessary if we are to see clearly their vivid coloring. Some live in ponds and streams, but the majority are land-dwellers, and many are serious pests, sucking the juices of fruit and plants, or infesting poultry. Others again are responsible for mange in horses, dogs, and cats. The disagreeable little bumps which we sometimes get on our arms and legs after a ramble through long rough grass in hot summer weather are caused by the tiny red harvest mite, which is no bigger than a needle point. It burrows into the skin and sets up the irritation.

Ticks also belong to the spider clan. They are larger than mites, and have somewhat flat, oval bodies. Some are brightly colored, but mostly they are dull gray, brown, or black. They vary in size from less than an eighth of an inch to over half an inch in length, and are often serious pests as the carriers of disease, not only to cattle, horses, sheep, dogs, and cats, but also to mankind.

Here sits the famous black widow spider in her web with her egg sac, and even people who hate to kill spiders had better slay this one before she bites, for her fangs are poisonous. She is found in almost every state of the Union, but especially in California, and she seems to prefer to live in man-made shelters. Her web is ugly to look at and irregular in form, as is proper for a spider who is such a menace to insect and human society. She has been called the "black widow" because of her glossy black or dark brown color and



Photo by University of California

because she often kills her husband. Occasionally people have died as a result of her bite, but usually the human victims recover. For a long while, however, the pain is acute and the symptoms severe, and those who are not familiar with such cases think they have acute appendicitis, food poisoning, lock-jaw, or ruptured gastric ulcers. The usual insect sprays and powders only make the black widow sleepy, but a spray of creosote will kill her, and will also keep her away. You may know her by the red spot on her under side.

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# AMPHIBIANS

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## Reading Unit No. 1

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### TUNEFUL FROG AND SOLEMN TOAD

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Why frogs and toads are called amphibians, 3-415-16  
Where toads and frogs spend the winter, 3-416  
From egg to frog, 3-418-21  
Why toads are usually let alone

by their enemies, 3-421  
How frogs croak, 3-422  
Tree frogs, 3-423-25  
Strange breeding places, 3-425-26

#### *Things to Think About*

Why must tadpoles stay in the water, while frogs and toads can stay on land?  
How does the spawn of frogs differ from that of toads?

What changes does a tadpole undergo before it turns into a frog or toad?  
How are tree frogs fitted for life in trees?

#### *Picture Hunt*

Why do toads like to visit a garden? 3-416  
What are the boxlike divisions seen in developing eggs? 3-417  
What happens to a tadpole's tail during development? 3-419  
Why are tree frogs hard to find? 3-420

Why is the under side of a frog whitish in color? 3-421  
Why do some people raise bullfrogs? 3-422  
What helps a tree frog to stick to the bark? 3-423  
Where may we find the eggs of a midwife toad? 3-425

#### *Related Material*

What process increases the number of cells in a living thing? 3-279

What other animals, besides toads and frogs, shed their skins? 3-482-83

#### *Leisure-time Activities*

PROJECT NO. 1: In the middle of March, visit a marsh and collect some frog's eggs. Keep them

in a tank of water and watch their development with a lens.

#### *Summary Statement*

Frogs and toads stand between fishes and reptiles, because they have gills when young, and lungs when fully grown. That is why their eggs must be dropped into

water. The eggs hatch into tadpoles, which look like fish. Later the tadpoles develop lungs for air breathing, their tails shrink, and legs form for a life on land.

## TUNEFUL FROG AND SOLEMN TOAD



Photo by Karl H. Muslowski

Fowler's toad is only two and a half inches long, but he has a mighty voice. For he inflates the air sac in his throat whenever he sings—as he is doing above—and

so has a natural drum to magnify the sound. You will hear his droning, musical call in April over the United States eastward from Michigan and west to Texas.

## TUNEFUL FROG *and* SOLEMN TOAD

### *Our Little Neighbors in the Swamps Have Very Strange Children That Never Go on Land During Their Youth*

**A** TOAD or frog could certainly never recognize its own child. When a young reptile is born or hatched you can tell at once what sort of creature it is going to be. Baby crocodiles, tortoises, lizards, and snakes are tiny independent animals exactly like their parents. They grow, but they do not change in any remarkable way.

Now frogs and toads, as you probably know, are not like this. When they start out in life they are not frogs and toads at all. They are queer little wriggly tadpoles, or polliwogs, not in the least like their parents.

Tadpoles are water babies. They live in the ponds and streams, where they swim about and breathe with gills just as fishes do.

The little things would die if you took them out of the water.

Grown-up frogs and toads, on the other hand, are land creatures. They live on the banks of the pools and streams, in damp meadows, or in any muddy, marshy places; and they have lungs to breathe with like all other land animals.

So toads and frogs are not reptiles. They are called amphibians (ăm-fīb'Y-ăn) because they have a double life, for originally the word was used of creatures living both on land and in the water. They spend their early days like fishes in the water; and then, after going through the most astonishing transformations, they hop ashore and turn into land animals. But all their lives frogs and toads continue to be fond of water.

## TUNEFUL FROG AND SOLEMN TOAD

You never find them in dry woods or hot, sandy fields. They would shrivel up if there were not enough puddles and wet weeds or mud about to keep them comfortably damp.

Amphibians, like reptiles, are cold-blooded creatures. But instead of being covered with

mouth and swallows them with gulps of satisfaction.

### Winter Homes of Toads and Frogs

In the winter months there are no toads to be seen squatting by the wayside or flopping along the muddy lanes, and no frogs to be heard croaking hoarsely in the evening down by the water's side. For as soon as cold weather sets in, all these creatures troop off to their winter quarters and go to sleep. Toads crawl inside hollow trees, shuffle under large, flat stones, or creep into holes in the ground, where the sharp frosts and the cold, wintry blasts are not likely to harm them. Frogs usually bury themselves in the



scales, they are most of them clothed with a soft skin, which is very elastic and can be stretched in a most astonishing manner.



Photos by N. Y. Zoological Society

They do not drink in the usual way, but absorb moisture through the skin; and there is nothing an old toad enjoys so much as sitting in a puddle and soaking up the water in undisturbed calm.

A frog's skin, as a rule, is damp and clammy, while a toad has a rough, dry skin covered with little warty lumps. Every two or three weeks all amphibians shed their outer dead skins just as reptiles do. The old skin splits and peels off in ragged flakes, and its owner almost always makes a meal of it. It is one of the funniest of sights to see a portly toad trying to get rid of his tattered old suit. He works away with his sturdy little hands, rubbing the loose pieces from his back, first on one side and then on the other; then he stuffs them into his

The common pond frog, above, and the common garden toad, below, with their queer lumpy bodies and great, staring eyes, are old friends to nearly all of us. Toads are an asset to the garden not only because they are amusing to look at, but because they eat up insects, besides. As for the frogs, what could be merrier than their agile antics, or the sound of their evening chorus in the spring?

mud, very often at the bottom of a pond; and there they stay, all huddled up together in bunches, until the warm spring sunshine

wakes them from their long winter sleep.

Then the frogs leave their muddy beds, the toads creep out of their holes and corners, and they all make their way to the ponds and ditches round about. There they soak themselves in the water and snap up insects and worms. The frogs begin croaking in chorus. They choose their mates and seem very much pleased to find themselves out and about in the warm, wet world once more.

But they do not spend all the bright spring days in idling and playing about. They have important work to do. Soon all the

## TUNEFUL FROG AND SOLEMN TOAD

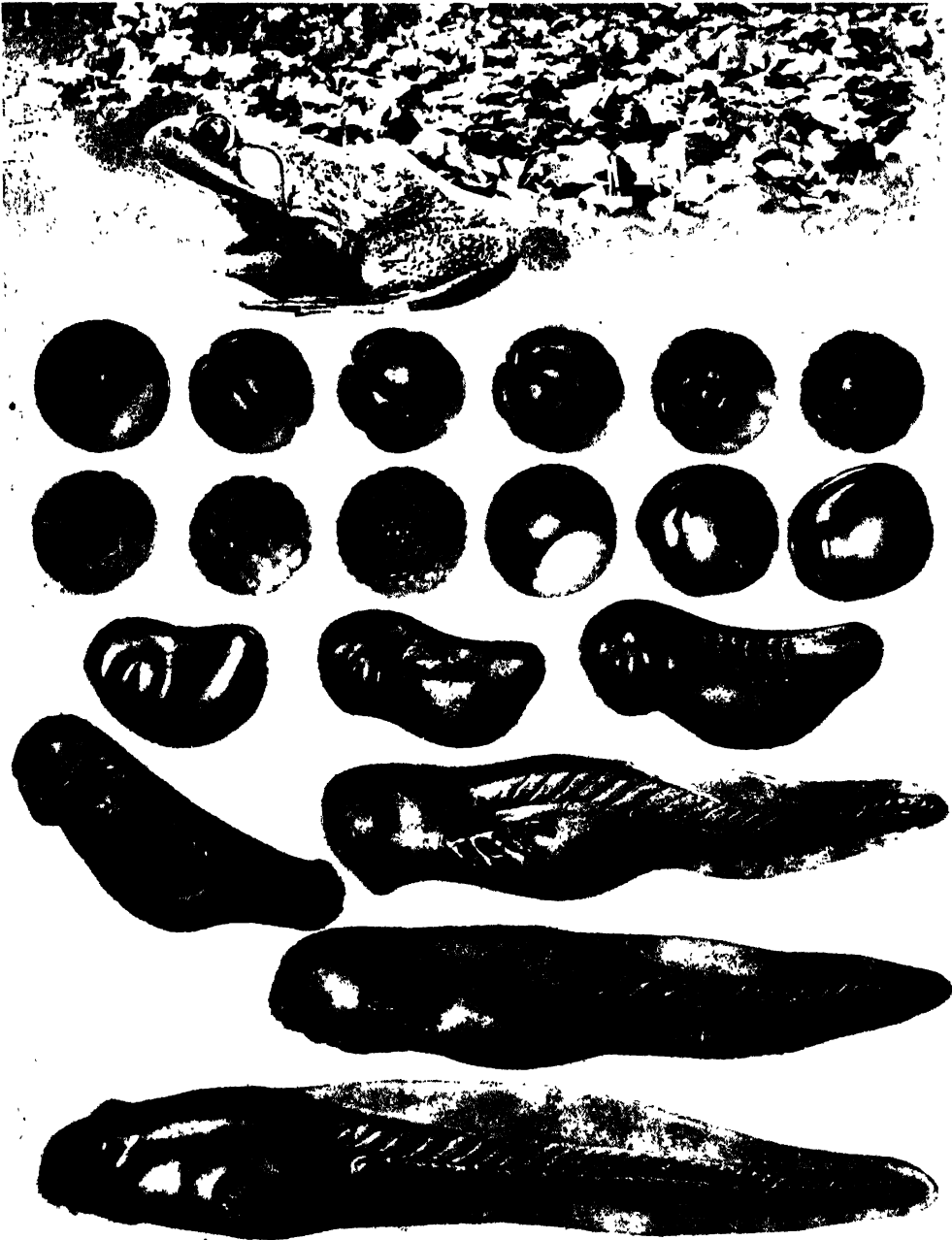


Photo by American Museum of Natural History

On this page we may see how a frog's egg turns into a tadpole. If you can get hold of a lump of spawn—the mass of jelly with eggs in it which the frog leaves in some pool—you can see the eggs hatch out under your very eyes. Just put the spawn in a dish of water in the house—and watch. These pictures are much larger than the eggs really are; so you will not be able

to see the first part of the process very well with your naked eye. The egg will split into more and more parts; then the tiny tadpole will begin to take shape. Little by little his head and tail and gills and eyes and all the other parts of him will grow. And finally he will wriggle out of the softened mass of jelly, and make for the warm, sunshiny surface of the water.

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## TUNEFUL FROG AND SOLEMN TOAD

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This giant tree toad is only one of the many species of tree dwellers among the amphibians. In this picture we can see clearly the round disks on the ends of its fingers and toes; with them it clings to the tree.

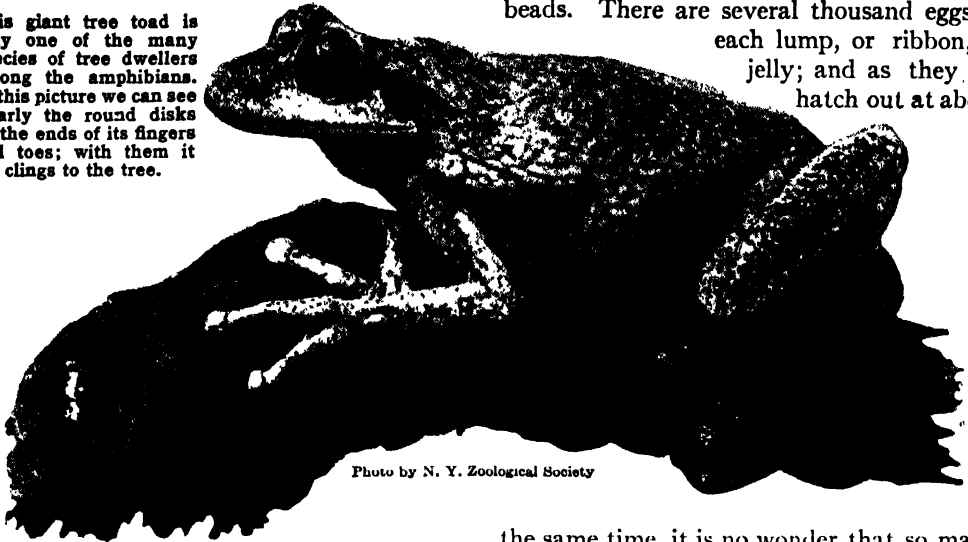


Photo by N. Y. Zoological Society

beads. There are several thousand eggs in each lump, or ribbon, of jelly; and as they all hatch out at about

the same time, it is no wonder that so many ponds and ditches are crowded with little polliwogs in the spring of the year. Toad tadpoles are rather smaller and darker than frog tadpoles; otherwise the little creatures are very much alike.

### How Polliwogs Breathe

At first the tiny polliwogs have feathery gill tufts to breathe with, which stand out on each side of the head like little waving plumes but are so very tiny that you can hardly see them without a magnifying glass. As they grow bigger the tadpoles lose their feathery plumes, and their breathing gills are hidden under little folds of skin, just as fishes' gills are.

### The Beginning of a Tadpole

This is the frog's "spawn." Each little jelly ball contains an egg; it is the dark spot in the center, or the "germ"—the living spark of life from which the wee tadpole will grow.

When the mother pops a batch of eggs into the pond, the little jelly balls are very tough and slippery. This prevents fishes and water fowl from gobbling them all up at once. But they gradually swell and soften in the water, and by the time the baby tadpoles are hatched and ready to make their escape, it is quite easy for the tiny things to push their way out through the sticky mass.

The toad's spawn is laid in a long ribbon of jelly instead of in a lump, and the dark round eggs in it look like strings of tiny

By this time the tadpoles are big enough to be seen, and what funny-looking little creatures they are! They seem to be all head and tail, and to have nothing at all in the way of a body. But the big round headlike thing is really head and body both; and hidden under its dark skin are the legs and all the other parts of the frog into which it is going to grow. In the meantime the odd water babies have all the organs they need for living in a pond—gills to breathe with, a pair of horny lips to eat with, and a long flat tail with which they swim through the water by striking out to right and left, just like a fish.

Tadpoles are very restless little beings. They are hardly ever still. When they are



## TUNEFUL FROG AND SOLEMN TOAD



Photos by N. Y. Zoological Society, and Russell Harrison

It would be hard to think of anything more fascinating than to watch the little tadpoles in some pond from day to day, as these children are doing. First they are wriggling mites so small you can hardly see them; then they grow larger and larger, as the pictures show, and develop hind legs, then front legs, at the same

time losing their tails. Then they hop off on shore, wee froglets about the right size for Doll-land. Some frogs take only a few weeks for all this, others two or three years. There is one frog called the paradox frog because it grows to be ten inches long as a tadpole—and then shrinks to two inches or so as a frog!

## TUNEFUL FROG AND SOLEMN TOAD

not wriggling about all over the place in a state of wild excitement, they cling in bunches to the water weeds, where they are constantly changing places, rudely pushing and shouldering each other out of the way in order to get into the middle of the bunch—which seems to be the favorite spot. They nibble the water



Try to trace the outline of this tree frog. It is easy since you know he is there; but you have probably brushed right past him many times without knowing he was anything but bark or leaves.

weeds and swallow all sorts of tiny soft things that float in the water—even their own brothers and sisters, now and then—and of course a great many of them are eaten up in turn by the larger creatures living in the ponds.

When the tadpoles are full-grown they begin to change in appearance. Their heads and bodies take shape, their legs—first the hind pair and then the front pair—break through the skin, and the little creatures now look like small frogs that have somehow grown long tails.

### From Tadpole to Frog

By this time they have acquired a pair of lungs to breathe with, while their gills are shriveling up and are no longer of much use. So they now come often to the top of the water and push their little noses above the surface to take in drafts of fresh air. Their tails, too, begin to shrink, growing smaller

and smaller every day. But before the tails disappear altogether, the little amphibians scramble out of the water as wee frogs and toads no bigger than your thumb nail, and start hopping and crawling about in the damp grass round the edge of the pond.

Crowds of tiny toads and froglets often swarm on the banks of ponds and streams in the summer time. It is just after they come ashore that we sometimes see whole regiments of the little creatures gathered together before they set off on their travels further inland. Frogs and toads are very independent beings.

Each one goes his own way. Mostly they move about and feed in the evening, and spend the day hidden in the grass or in the mud. But after a spell of dry weather, large numbers of frogs and toads leave their hiding places on a dull, wet day and assemble to enjoy the refreshing rain;

in the spring-time, too, they gather at the water's brink for their nightly choruses. Very few, however, of the tiny

things who leave their watery home for the dry land ever take part in these evening concerts. Frogs and toads are not full-grown until they are three or four years old, and before that time they have many dangers to meet. If they hop back into the water for a swim they run the risk of being snapped up by hungry fishes, while on land they may be

A toadstool, in spite of its name, is hardly the seat for a toad.

Photos by Cornelia Clarke, and N. Y. Zoological Society



This fat, spotted creature is a salt-marsh frog.



## TUNEFUL FROG AND SOLEMN TOAD



This leopard frog takes his name from his spotted skin, which reminds us of the skin of a leopard. As we see in the picture above, he wears his handsome coat only on top, where everyone can admire it.

Photo by N. Y.  
Zoological Society

eaten by the snakes and birds and beasts. So out of all the thousands of polliwogs that hatch out of each batch of eggs, only two or three are likely to grow up.

Toads and frogs are alike in many ways. Both have big beautiful eyes that shine like precious jewels in their heads; both have huge, wide mouths and long sticky tongues. They both feed on small creatures such as insects, worms, slugs, or even baby toads and frogs which have not been long out of the water. As a rule they will not touch anything until they are quite sure it is alive. You may see an old toad sitting bolt upright on its haunches, gazing with intense excitement at a big fly resting on the ground. Presently the insect moves a leg. That seals its fate. Quick as a flash the toad makes a dart with his long sticky tongue, and the fly disappears down his

throat. If the victim is a worm too large to be swallowed with a single gulp, the toad lurches forward, seizes it by the middle, and then crams the two wriggling ends of the creature into his mouth with his hands.

Frogs are much more lively than toads. With their long hind legs they spring and leap about like acrobats when they are ashore, and the same legs, with their webbed feet, make them capital swimmers when they are in the water. The toad's hind legs are not so long, and he cannot skip about with such agility. His usual mode of progress is a jerky crawl, though when he is in a

hurry he can get along more quickly by taking little hops. He is rather a poor

swimmer, too, and does not spend

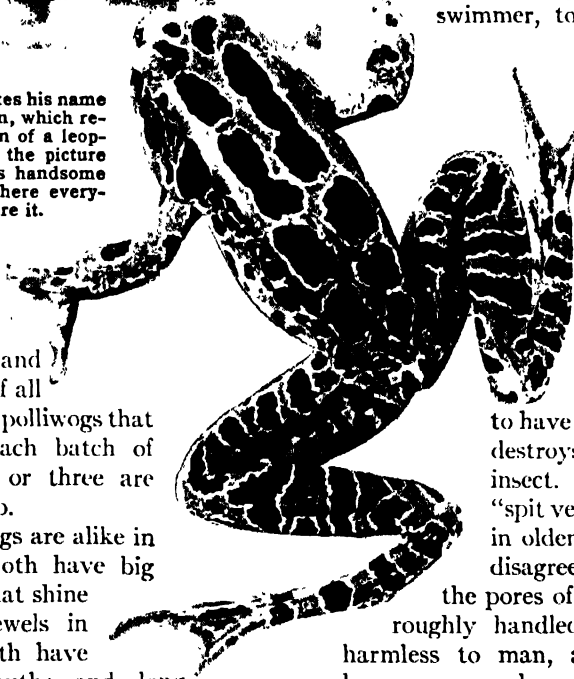
so much time in the water as the frog does.

As a rule, he prefers to sit in a puddle or squat in damp grass.

Many people are afraid of a toad. They call him a horrid creature and think he is poisonous. But the common toad is a most harmless fellow, and a very useful one

to have about the garden; for he destroys many a troublesome insect. Although toads do not "spit venom," as people thought in olden days, they do exude a disagreeable milky fluid through

the pores of the skin when they are roughly handled. This fluid is quite harmless to man, as a rule, although it leaves an unpleasant smell on your skin and will make your eyes smart if you rub them just after you have touched one of the creatures. But to many animals it is really poisonous. No wise dog will touch a toad, and if he does pick one up while he is still a foolish puppy, he will drop it in a hurry and never repeat the experiment. Some kinds of frogs, too, are not at all nice to handle—and a few are actually poisonous. The milky stuff that oozes from the skin of one small frog found in Colombia is used by the natives to poison their arrows.



## TUNEFUL FROG AND SOLEMN TOAD

This lord of the pond is an American bullfrog. It is his voice which booms loudest in frog concerts. And it is his fat hind legs which oftenest find their way to our tables as the delicate frogs' legs dear to the good cook's heart.



Photo by Field Museum

As a rule frogs are far more noisy than toads, though both can make some kind of sound when they are pleased or alarmed. It is the males that croak so lustily when they gather around the ponds on warm spring nights. They are just showing off to attract attention from their mates, and each one does his best to sing louder than his neighbors. The lady frogs seem to enjoy these singing contests, though they usually listen in silence or show their pleasure only by little grunts.

### How a Frog Croaks

When a frog or a toad croaks he keeps his mouth shut and his throat swells up like a blown-out paper bag. In his throat is a pouch of very fine skin called a "vocal sac." When it is filled with air, this pouch adds to the volume of the sound; and that is why so loud a noise comes from so small a creature.

Some frogs have two of these pouches, one on each side of the throat. The European water frogs and a few others even have slits in the skin through which the pouches bulge and swell out like balloons when the frogs are croaking.

The American bullfrog is a champion croaker. His love song on a quiet night can be heard nearly a mile away. He is a fine fellow with an olive-green coat and a bright yellow waistcoat, but he changes color a good deal, appearing light green in a bright light and almost black just after he has come out of the water. He is a splendid swimmer

and diver, and is fond of sitting up to his middle in the water at the edge of his own particular pond while he sings or waits for his supper. He eats all sorts of water creatures, including smaller frogs; and he sometimes drags little ducklings and other wee water fowls below and swallows them. But he is eaten up in turn by otters, snakes, birds of prey, turtles, and alligators.

### The Largest Frog in America

The bullfrog is the largest of all American frogs. When quite grown up he is often six or seven inches long. The tadpoles live two or sometimes three years as water babies, and are almost as long as full-grown bullfrogs before they change their shape and their habits and hop ashore for the first time.

The Indian bullfrog is nearly as big as his American cousin; but largest of all the frog tribe is the "giant frog" of Africa. This monster sometimes measures over a foot in length. It must be rather startling to meet him hopping over the ground with his giant strides.

### The Frog That "Plays 'Possum"

One of the smallest frogs is the "dwarf frog," which is hardly an inch long. It lives in South America, and is quite black, except where it is marked underneath with splashes of bright orange or crimson. When it is frightened, this little frog does not hop off in a hurry, but instantly turns over on its back.

Almost as small is the tiny North American cricket frog. He is a merry little fellow

## TUNEFUL FROG AND SOLEMN TOAD

dressed in a spotted suit of reddish brown—fond of sitting on the broad leaves of water lilies while he chirps away like a cricket. But he is very nervous, and if anything disturbs him, he bounds from his leaf as if shot from a catapult, plunges into the water, and hides himself in the mud at the bottom.

### Frogs That Live in Trees

Most delightful of all little frogs are the pretty North American tree frogs that trill away so cheerily in the woods, fields, and orchards all through the summer from June to September. Instead of hopping about the ground in the usual way, these funny acrobatic little creatures spend their days up among the branches of the trees. There they cling to the leaves with the round, sticky pads on their fingers and toes, and take flying leaps from one bough to another as they hunt for beetles, flies, and caterpillars in the cool of the evening.


Some of these frogs make their homes in the cracks and crevices of old moss-covered walls; others love the cornfields, where they are sure of finding plenty of insects to feed on. In the daytime the little field dwellers hide under the broad leaves of the corn, or tuck themselves into the green pockets between the bases of the leaves and the stems of the plants, which make delightful nooks to snuggle into. In the evening and the early hours of the morning they creep out of their hiding

places and grow very lively; and their little tinkling call, which sounds like the note of a distant cowbell, may be heard all over the field.

The common tree frog—or tree toad as it is often called—of Eastern North America is one of the best known of these little creatures, for he often makes his home in the trees in the garden or in the vines upon the houses. He has everything that the heart of a tree frog could wish for—cool green leaves to shade him and keep his skin moist; ever so many dark nooks and corners to sleep in; and above all, plenty of juicy caterpillars and nice things like that. And how the frog rejoices when the rain patters down and drums on the leaves of his tree! Then his throat swells and he sings aloud for joy.

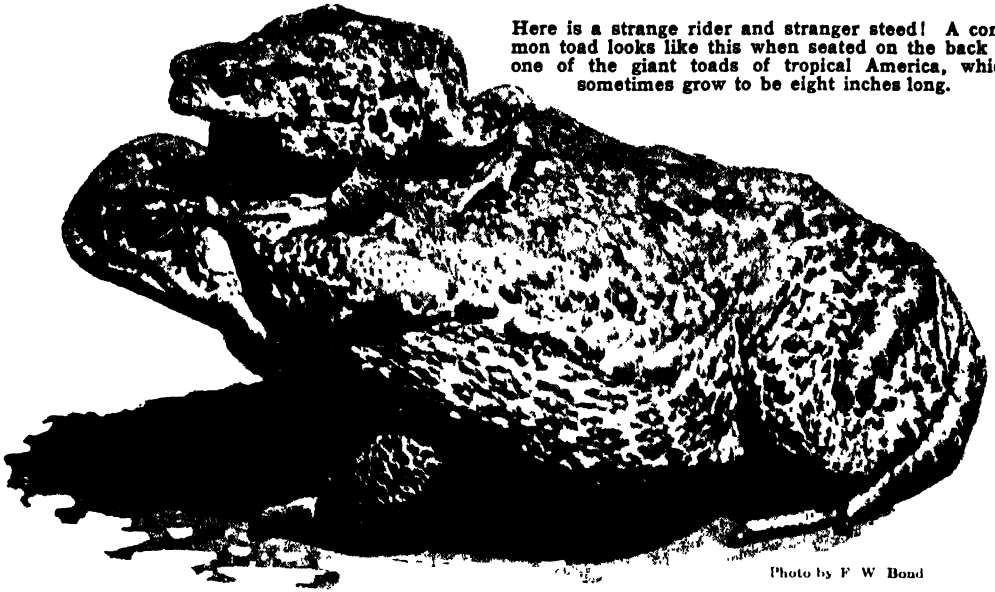
Tree frogs are most noisy at night, like their relatives who live on the ground, but they often lift up their voices in the day if it is dull and cloudy. "When frogs croak it is going to rain," people say. This is sometimes true, though it does not do to depend on the little weather prophets—they are not always right.

There are a great many different kinds of tree frogs, mostly dressed in some shade of



Above is the green tree frog, perhaps the most beautiful tree frog in North America. He is about two inches long, with fine, smooth, green skin. Below him is a northern, or mink, frog—a silent, solitary river dweller. He gives off a disagreeable odor said to be like that of the mink—hence his name.

## TUNEFUL FROG AND SOLEMN TOAD



Here is a strange rider and stranger steed! A common toad looks like this when seated on the back of one of the giant toads of tropical America, which sometimes grow to be eight inches long.

Photo by F. W. Bond

green, gray, or brown; but they have a bewildering way of changing color to suit the occasion, and this makes it very hard to see them when they are sitting still. Surrounded by bright green leaves a tree frog will be bright green too. When resting on a tree trunk he looks like a small patch of grayish-green lichen. If he goes to sleep on a wall with his legs tucked underneath him he might be a little lump of gray mortar or a dab of yellowish putty.

Tree frogs are very confiding little things. If you pick one up very gently he will sit quite still, clinging tightly to your fingers with his sticky toes and gazing at you solemnly with his big bright eyes. Then suddenly, without any warning, he springs high into the air and is gone. But look around carefully and you will find the little fellow calmly watching you from his perch on a post or wall, or from the ground.

All over the world, except in South Africa, tree frogs may be found hopping about the trees whenever the climate is warm enough and damp enough to suit them. In South America, in Southern Asia, and in Southern Europe, these froglets lift up their voices at dusk and keep busy catching and eating all sorts of destructive insects. In Borneo there are some very curious ones called

flying frogs. They do not really fly, but they have very large webs between their fingers and toes, and these act as parachutes to enable them to take long leaps from the tree tops to the ground.

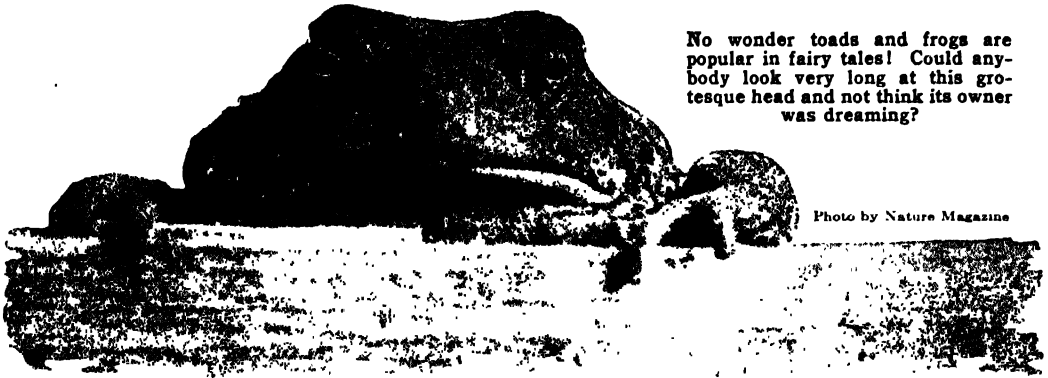
In the winter tree frogs bury themselves in the mud or creep into holes in the ground, just as other frogs do, and in the spring they come forth and troop down to the ponds and brooks to lay their eggs. Some anchor their eggs in small bunches to grasses and twigs in the water; others roll them up carefully



The golden tree frog of Australia is one of the most beautiful of all the amphibians. Its back is green with streaks of gold.

Photo by N. Y. Zoological Society

## TUNEFUL FROG AND SOLEMN TOAD



No wonder toads and frogs are popular in fairy tales! Could anybody look very long at this grotesque head and not think its owner was dreaming?

Photo by Nature Magazine

in the leaves of water plants. One South American tree frog actually carries her eggs in a pouch on her back. Another frog makes a genuine little nursery for the young tadpoles to hatch out in.

This thoughtful frog lives in South America too. It is called the "smith," because when it croaks it makes a noise like the banging of a hammer on a copper plate. While it is croaking, its mate is working away in silence making the nest. In shallow water near the edge of a pond she builds up a neat round wall of mud, smoothing it carefully inside and all around the top with her hands—just as a mason would do with his trowel. Her croaking mate does not help her at all, though he sometimes climbs up on top of the wall and looks down at the work.

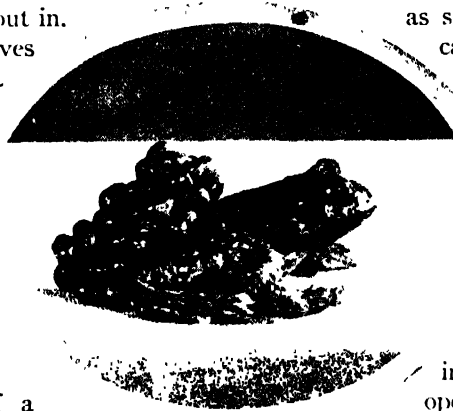


Photo by American Museum of Natural History

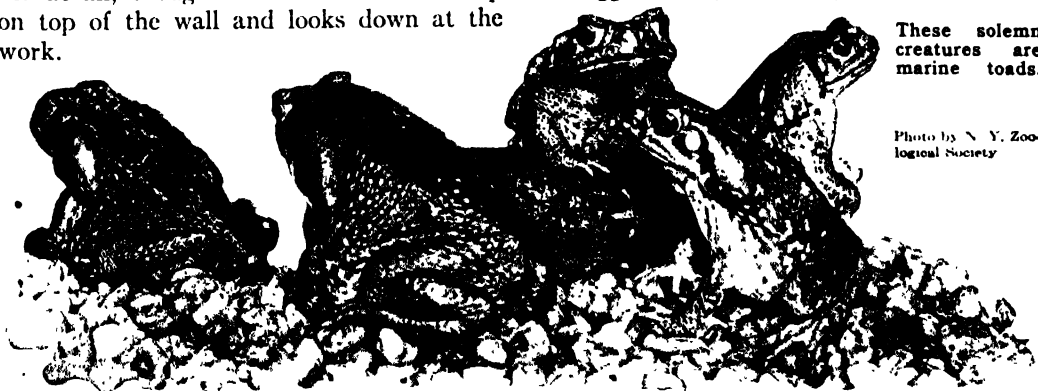
This mournful creature is the midwife toad, who carries his spawn on his back.

The male frogs seldom take any interest in their children. But there are exceptions to the rule. One little South American fellow takes the eggs in his mouth as soon as they are laid and carries them about in his throat pouch. When they hatch, the tadpoles do not leave their strange nursery at once, but stay there until they have changed into frogs. Then one fine day, when his children are ready to come out into the world, the father opens his mouth and all the children tumble out and hop away.

There is a small European toad, called the "midwife toad," which is also a good and careful father. He winds the long strings of bead-like eggs, laid by his mate, round and round

These solemn creatures are marine toads.

Photo by N. Y. Zoological Society



## TUNEFUL FROG AND SOLEMN TOAD

his hind legs and retires with them to a hole in the ground. There he waits patiently, coming out only at night to feed. When the eggs are ready to hatch, off he waddles down to the water and lets all the baby polliwogs go free.

Another toad—a mother toad this time—carries her eggs about on her back. The male lifts them and places them in position for her, and they sink into her soft, thick skin. Each egg lies in a separate little pocket, and the sticky film on top of it soon becomes hardened and forms a tight-fitting, horny lid. For nearly three months the patient toad moves about with her strange burden. Then one by one the little lids are pushed up, and seventy, eighty, or maybe a hundred tiny toads scramble out and tumble off mother's back. This toad is called the Surinam (sōō'rĭ-nām') toad. It is a strange, awkward-looking creature with a pointed snout, and it lives in the damp forests of Brazil and the Guianas.

The largest toad of all is the "giant toad" of Central America. It is as big as any bullfrog, and its loud croak is like a hoarse bark. The smallest is the wee oak toad, which is not much more than an inch long.

This little fellow lives in Carolina, Georgia, and Florida, and is usually found in sandy places where there are plenty of shallow pools and low oak scrub growing round about. He is a bright little creature in a dusky brown coat and a light waistcoat, while the palms of his hands and the soles of his feet are bright orange. He is often mistaken for a baby toad, because he is so small, but he never grows any bigger. He is more often heard than seen, for he sounds like the squawk of a frightened chicken.

There are many odd-looking toads and frogs. The horned frog of Brazil is one of the most peculiar. It is very large and stout, and almost as round as a ball. Over each eye is a triangular lump; its mouth is simply enormous; and its crinkly skin is marked with spots and splashes of green, orange, brown, black, and yellow, arranged in patterns like a gorgeously colored carpet. Horned frogs are fierce creatures. If teased, they puff themselves out to such an extent that you would think they must burst like the boastful frog in the old fable. But this is not all. The angry creatures will come hopping after you and try to bite you. But their bite is not poisonous.

This is the Surinam toad, a creature so strange as to be almost beyond belief. It lives in the forests of Brazil and Northern South America; and the mother has about the most amazing of all ways of taking care of her children. You probably would never guess it if you had no hint.

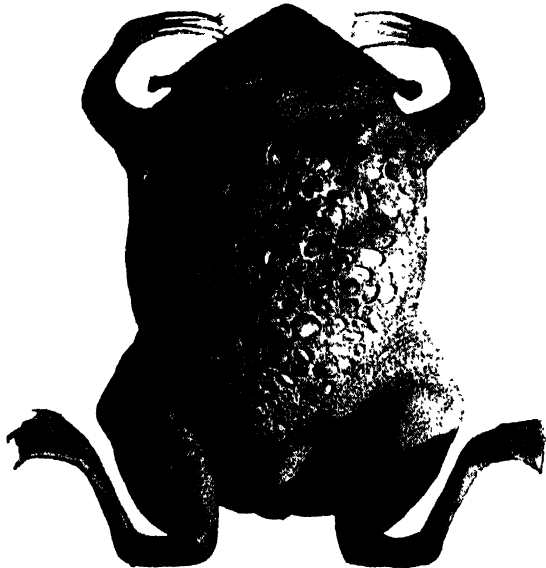


Photo by American Museum of Natural History

After the eggs have been laid, the father picks them up and places them on the mother's back. There they sink into the skin, each egg in its own little pocket, which then grows a horny lid. After eighty-two days, the little toads hatch and each one lifts its lid and tumbles out.



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# AMPHIBIANS

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## Reading Unit No. 2

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### NEAT LITTLE NEWT AND SALAMANDER

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The difference between newts and frogs, 3-428  
How mother newts protect their eggs, 3-428-29  
Where to look for newts and salamanders, 3-429

Giant salamanders, 3-430  
Salamanders that never see daylight, 3-431  
A salamander that hardly ever grows up, 3-431

#### *Things to Think About*

What group of amphibians never lose their tails?  
How can you tell whether a tadpole will become a frog or a newt?  
Why are salamanders found in

damp parts of the woods?  
Can salamanders live in fire?  
What changes have taken place in salamanders that always live in caves?  
What makes an axolotl grow up?

#### *Picture Hunt*

What makes salamanders return to lakes and ponds in the spring? 3-428  
Why are salamander eggs very large? 3-429  
What structures may be looked

for in salamanders that never leave the water? 3-430  
How can the white salamander be made to change its color? 3-431

#### *Related Material*

From which group of animals did salamanders inherit their gills? 3-196

What other animals live in pools in which salamanders are found? 3-\*222

#### *Leisure-time Activities*

PROJECT NO. 1: In March, visit a swamp and look for the large, jellylike eggs of salamanders and newts. Keep them in old aquarium water and watch

their development. During and after a rain, visit the woods and hillsides for red salamanders, 3-429

#### *Summary Statement*

Newts and salamanders are amphibians like frogs and toads; but they still keep the tails they had as tadpoles. Some salamanders retain their gills all their

lives because they never go on land. Land salamanders lose their gills and return to the water when the time comes for them to lay their eggs.

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## NEWTS AND SALAMANDERS



Photo by N. Y. Zoological Society

A newt, as is clear from this picture, looks a little like a polliwog which is about to turn into a frog. After he is full-grown, he usually spends his time on shore—and he does not stick to streams and bogs, as frogs

like to do. But in the courting season he takes to the water again, dashing about and proudly flicking his flat tail, which usually is ornamented by a ridge or crest on top. Here he is shown leaning against a glass.

### NEAT LITTLE NEWT *and* SALAMANDER

*Some of Them Spend the Winter Frozen Solid in a Cake of Ice, and Others Refuse to Grow Up and Go Out into the World*

**I**T WOULD seem that Mother Nature is willing to let her children do just about as they please so long as they do not harm themselves too much with their whimsical notions. She seems quite willing that frogs and toads and newts and salamanders should go their own way and spend the first part of their lives in the water and the rest of it on land. All she asks is that they should be strong and healthy and look after their eggs properly and not be silly about running into danger. And because they have followed her wishes in all these matters, they have lived and multiplied until they are the fine healthy tribe that we know. We call them "amphibians" (ām-fīb'ī-ăn) just because they spend the two parts of their lives under such different conditions; the word, which is from the Greek, means "having a double life," and

was at first applied to all creatures who lived both on land and in the water.

But the newts and salamanders have hit on a scheme that is different even from the habit of their close relatives, the toads and frogs. For toads and frogs leave their tails behind them when they quit the water and no longer need them for swimming, but newts and salamanders keep their long tails all their lives. So toads and frogs are called "tailless amphibians," and newts and salamanders "tailed amphibians."

Newts begin life as water babies, just as toads and frogs do. At first all the little tadpoles are much alike, but as they grow older you can tell which are which, for the newt tadpoles grow their front legs first, and do not lose their tails.

The female newt is most fastidious about her eggs. She pops them here and there

## NEWTS AND SALAMANDERS

upon water weeds, each one separately, and twists or folds the leaves around them to keep them safe from hungry water folk. She uses her hands and feet to twist and fold the leaves, and sometimes gives them a little nip with her jaws to make things more secure.

Most young newts spend the first year or two of their lives on land, hiding under stones and logs or piles of damp leaves and moss. They often wander far afield and turn up in unexpected places, such as damp sheds and cellars. They even appear in the coal scuttle occasionally, having been shoveled up with the coal.

In cold weather they are dull and torpid, and their spotted coats are dark and dingy. But in the spring they grow quite lively and are very smart indeed in their courting suits. Their skin becomes bright and glistening, and gleams with tints of red, green, and orange, while fine upstanding crests appear upon the backs of most of the males. The male newts at this time are very proud of themselves. They ripple their crests and wave their tails to show the lady newts how fine they are. The lady newts, too, have pretty spring dresses, but as a rule they have no crests on their backs.

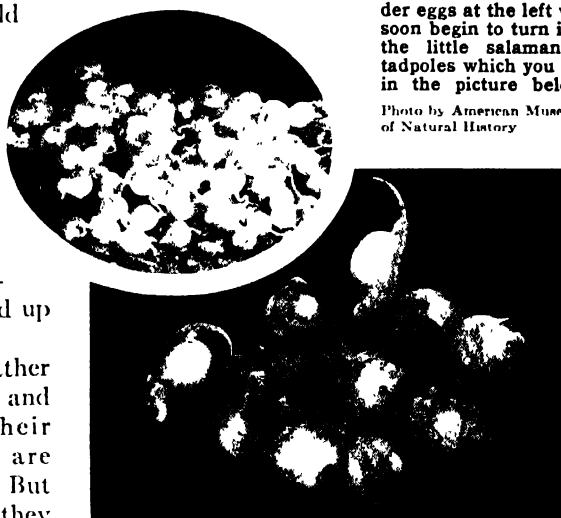
### Queer Ways of the Salamander

Salamanders (să'l'ă-măn'dēr) are very much like newts; indeed in the United States we make no real distinction between the two. But their tails are rounded and tapering, instead of flattened and oar-shaped; so in general they look more like lizards. Although they are born in the water and spend their early days there, many of them live on the land after their tadpole days are

over. They love damp, shady spots, and hide under stones, rotten tree stumps, and moss in the daytime, coming out to feed at night on worms, snails, beetles, woodlice, and other small live things. They are wonderfully hardy creatures; even though frozen in ice or dried up in mud, they will come to life again when the sun melts the ice or the rain softens the earth. If they chance to lose a finger or toe, or even an arm or leg, they need not worry much, for in a few weeks' time they grow new ones. But there is one thing a salamander cannot do. It cannot live in the fire as people used to say it could.

The mass of salamander eggs at the left will soon begin to turn into the little salamander tadpoles which you see in the picture below.

Photo by American Museum of Natural History



The brown salamanders of the Eastern United States live mostly near running brooks shaded by trees, where they lurk in the wet sand or mud under stones. Best of all they love the little mountain streams that flow

swiftly down the hillsides, forming miniature cascades and small shallow pools on the way.

### Salamanders That Love Dry Land

Certain Californian salamanders often live wholly away from the water and nearly always make their homes under rotten logs and stumps. They do not even seek the ponds or streams to lay their eggs, but place them in a hollow in the ground and coil around them until they are hatched. Strange to say, these young Californian salamanders are not tadpoles when they are hatched, but are already salamanders. If you put them in the water they are very unhappy, for the poor little things cannot swim and immediately sink to the bottom.

The black salamanders, too, are born on dry land as air-breathing creatures. They live on the Alps, some three thousand feet above sea level, and may never see a pool or stream at all. Yet the fire salamanders,

## NEWTS AND SALAMANDERS



Photo by N. Y. Zoological Society

Some newts and salamanders lose their gills when they grow up, as frogs and toads do, and some keep them always. It depends on whether the grown creature is going to live in the water all the time or become

a land dweller. The mud puppy in this picture is not the most beautiful of the salamander tribe, but he does keep his fine gills, which are a bright crimson. Even so, what real puppy would own him as a brother?

who also live high up in the world, start out in life as water babies in the true amphibian way. Fire salamanders live in Southern and Central Europe and in some parts of Africa and Asia. They make their homes in wooded districts on the slopes of the mountains, and have jet-black coats marked with bright yellow or orange spots and stripes.

### The American Hellbender

The "giant salamander" of America—or "hellbender," as he is sometimes called—is much fonder of the water than most of his kind. He is a stout fellow, fully half a yard long, and he lives all the year round in the streams and rivers of the Eastern United States. Fishermen do

not like the hellbender at all, for besides eating quantities of fish he makes himself a nuisance by biting the bait off the hooks.

### The Largest Living Amphibian

The giant salamander of China and Japan is not unlike his American cousin—a queer-looking creature with a broad flat head—but he is more than twice as big, for when full-grown he may measure four or even five feet from his blunt nose to the tip of his tail. This monster, the largest of living amphibians, usually lives alone under protecting rocks in swiftly-flowing streams.

When the Mexican axolotl gets about this far in the process of changing from tadpole to salamander, he is so well pleased with himself that he stops right there.

Many of the salamanders are very strange in their ways. The sirens, which are

Photo by N. Y. Zoological Society



## NEWTS AND SALAMANDERS

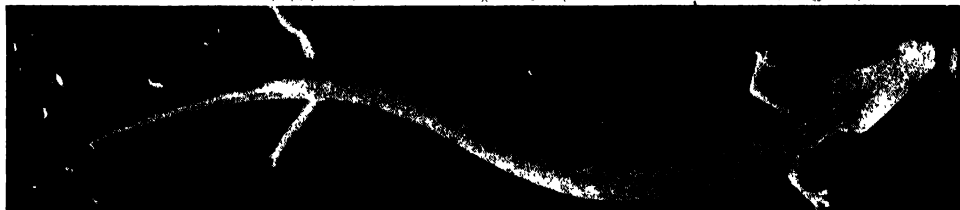


Photo by American Museum of Natural History

Above is the olm, or proteus, the strange blind salamander that lives in underground lakes in Europe. It

is white, with bright red gills. But if long exposed to the light, its skin turns jet-black.

North American salamanders, spend most of their time buried in the mud in the banks of ponds and ditches. They have long eel-like bodies, very small front legs, and no hind legs at all, and are commonly called "mud eels."

Stranger still is the proteus, or blind cave salamander of Europe—a strange creature living in the dark waters that flow through deep caves and grottoes far below the surface of the earth. No ray of light ever penetrates these gloomy caverns; but this does not matter to the proteus, for it is quite blind.

Few people have seen this queer salamander, for only very seldom—at flood time, when the waters rise to their greatest height—does it appear in the upper world. It is a queer creature, long and thin and snowy white, with a tuft of bright red feathery gills on each side of its head, and with legs so small and weak that they are of no use at all for walking or swimming.

Perhaps you wonder what such a creature does in its dark home underground. One might almost say it does nothing. It spends most of its time lying motionless among the stones at the bottom of the water, snapping at anything good to eat that floats within its reach. For although the proteus is blind it is not deaf, and it can tell by the movement in the water when a tiny shrimp or fish is passing by.

The proteus is an Old World salamander, and has never been found anywhere except in underground streams in certain parts of Austria. For a long time it was supposed to be the only one of its kind to live in so strange a way, but some years ago another cave dweller was discovered in underground waters in Texas. It is blind like the proteus,

and perfectly white except for its blood-red gills. Unlike most amphibians, these two salamanders and the "mud eel" and the "mud puppy" do not lose their gills when they grow up, because they always live in the water.

The mud puppy is a salamander with fine crimson gills. It lives in the Great Lakes and in many rivers of Central and Eastern United States.

Lastly, there is an old salamander called an axolotl (ăk'sô-lôtl) that lives in the lakes of Mexico City and does not behave at all as you would expect an amphibian to do. The name "axolotl" is a Mexican word which means "play in the water"—and that is exactly what this salamander does all its life long. When its tadpole days ought to come to an end, the axolotl does not change into a land animal in the ordinary way, but simply grows bigger and bigger until it looks like an overgrown tadpole eight or nine inches long.

Why it acts in this way no one knows exactly, for it *can* grow up if it wants to. If, before it grows too big, it is taken from its home and transferred to a very shallow pool where there is enough water to cover it comfortably, the tadpole acts more naturally. It goes through its changes in the regular way and turns into an ordinary salamander. But at home in the lakes of Mexico, the axolotl is quite content to stay as it is. There it has plenty of cool, well-aërated water to swim and breathe in, lots of jolly places to hide in among the reeds and rushes, and an abundance of the kind of food it likes best. So the little creature continues to play in the water and, like Peter Pan, it never grows up.

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# REPTILES

## Reading Unit No. 1

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### ANIMALS WITH COLD BLOOD

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

What the world looked like millions of years ago, 3-433-34  
Ancient reptiles, 3-434  
Why reptiles like warm places, 3-

434  
The covering of a reptile, 3-434  
Where reptiles live, 3-434

#### *Things to Think About*

How was the ancient landscape different from the modern?  
How did plant and animal life in the ancient world differ from that of to-day?  
What ferocious animals once

ruled the earth?  
Did any human beings see live prehistoric reptiles?  
What makes reptiles different from other kinds of animals?

#### *Picture Hunt*

How have scientists learned what dinosaurs looked like? 3-434  
What caused the ancient dino-

sosaurs to die out? 3-434  
How long were some of the ancient dinosaurs? 3-434

#### *Related Material*

What did some ancient dinosaurs look like? 3-37-42  
How did dinosaurs reproduce their kind? 3-39

When did dinosaurs rule the earth? 3-37  
Which dinosaurs took to flying in the air? 3-42-43

#### *Summary Statement*

Reptiles are backboned, air-breathing animals with a dry, scaly skin. They are cold-blooded and are sluggish in cool weather. Reptiles flourish in warm places. Millions of years ago, when the climate was warm the world over, gigantic reptiles roamed the land.

Their tiny brains and ravenous appetites finally led to their destruction. No man lived to see any of them alive. To-day we still have reptiles; but they are only a small remnant of the vast numbers that once lived.

## ANIMALS WITH COLD BLOOD

These grotesque creatures are not dragons out of some fairy tale, but living monsters that waddled through the steamy jungles uncounted ages ago. Of course no one ever saw a dinosaur to draw his picture, but we may all see their enormous skeletons in the museums of natural history. And the scientists who have dug up the bones and fitted them together can tell by many signs what this one ate and how that one walked, and something of how all of them must have looked in their prime. In that far-off day there were no mammals bigger than a rat, and these gigantic reptiles were monarchs of the living world. But in the end their very size was their undoing—especially since the biggest had a brain no larger than that of a small dog!

It is the biggest dinosaur, the Brontosaurus, which is here being bitten by a comparatively little one named Tyrannosaurus. Even this "little" one was the largest flesh-eating animal that ever lived on land. He was a very dangerous creature indeed, as we can see. He went about preying on his big cousins, who were so awkward and stupid that they were fairly easy prey. He probably liked a diet of mammals well enough, too, but though the mammals could not fight him, they were clever and swift and often ran away. As for Brontosaurus, he lived on plants. His long neck made him so tall he could eat the leaves from the tree tops. If he had had warm blood like a mammal he would have needed a great deal more food than he did need to feed his vast bulk; there probably would not have been enough food in the whole world to support the number of his kin which seem to have inhabited it.



Photo by Sinclair Oil Co.

## ANIMALS WITH COLD BLOOD

*The Lizards Eighty Feet Long That Mother Nature Once Experimented with Have All Disappeared, but Other Smaller Creatures of Their Kind Still Walk the Earth To-day*

**O**NCE upon a time, long years ago, the world was a very strange place indeed. There were no towns, cities, or villages, and there were no woods and meadows and rolling prairies as there are to-day. The earth was covered with immense tracts of wild, desolate land, dismal marshes, and great swampy jungles where the strangest plants and trees grew. There were huge tree ferns, giant mosses, towering horsetails, and trees with queer scalelike leaves, but no oaks, beeches, or redwoods, nor any of the trees of our woods and forests to-day.

The world in those far-off days must have been a dreary place. No birds sang, no monkeys chattered in the branches of the trees; no herds of graceful deer trooped down to the pools to drink in the cool of

the evening; no lions or tigers roared in the jungles—for there were no animals like those that live in the world to-day.

There were odd-looking scorpions, centipedes, and many strange insects creeping and crawling over the swampy ground. Long-legged grasshoppers cheered things up a little with their chirping; and big beetles droned as they blundered about in the hot, steamy air, while giant dragon flies pursued and killed them on the wing.

But this was not all. In the forests and jungles, and in the waters that flowed through the land, dwelt all manner of fearful and gigantic creatures—huge and hideous reptiles who ruled the earth in those far-distant days that we call the Reptilian (rēp-tīl'ī-ăn) Age. Scaly monsters as big as

## ANIMALS WITH COLD BLOOD

alligators hauled themselves out of the dark pools and basked upon the mud banks; terrible lizards eighty feet long dragged their ugly bodies over the ground; gigantic creatures with squat, misshapen bodies and giraffe-like necks straddled about the jungles and browsed upon the tree tops; and fearsome "flying dragons" with vulturous heads, long tails, and bats' wings flapped their way through the stifling air in search of prey.

No human eye ever saw these terrible creatures alive, for there were no human beings in the world to see them so many thousands of years ago; but their skeletons have been found in the rocks, so we know fairly well what they must have looked like. Fortunately for us there are no such appalling creatures going about the world to-day. All the fearsome, prehistoric monsters died out long ago. Yet many of the living reptiles are alarming enough, and some, although they are not so enormous, are still very much like their ancestors.

Few people like reptiles—and this is not very surprising. The creatures seem cold and unfriendly, not at all the sort of animals we should care to make pets of. Yet, as we shall see, many of them are most curious and interesting; and some of the smaller lizards are really delightful little things.

The reptiles living in the world to-day are the crocodiles and alligators; the tortoises and turtles; the snakes and the lizards. They are cold-blooded creatures—that is to say, they have no warmth of their own. Their temperature rises and falls with the temperature of the air around them. Consequently reptiles are always most happy and comfortable when they are in a thoroughly warm place, and grow dull and sluggish when the air is cold. We find many more of these cold-blooded creatures living in hot tropical countries than in temperate climates, and none at all in the coldest regions of the world. A few lizards and snakes

live in the dry, burning deserts of Africa and Asia, but as a rule reptiles prefer hot damp places and are most at home in swamps and steamy jungles, as were their ancestors of olden days. Many spend more than half their time in the water.

Although they are called creeping creatures—for that is what the word "reptile" really means—not all reptiles crawl. Some of the little lizards are most energetic, and whisk about in the sun with lightning speed; and even clumsy crocodiles can run fast enough when they want to—as many a warm-blooded animal finds out to its cost when one of those fearsome creatures is after it. But most reptiles do not run. Tortoises plod along in a slow and dignified manner; crocodiles and big lizards drag their heavy bodies over the ground between their four stumpy little legs; and snakes, which have no legs at all, glide or wriggle through the grass or the low, tangled brushwood.

Some reptiles are clad in strong bony armor or are protected with horny shields; others are covered with scales; and a few have merely leathery coats. But no reptile is ever clothed with hair or wool, as warm-blooded animals are.

Nearly all reptiles, except the tortoises, are carnivorous (*kär-nīv'ô-rūs*)—they live by killing and eating other animals. Many are armed with sharp curved teeth, while others overcome their enemies or their prey with deadly poison.

Young reptiles are usually hatched from eggs. They are shaped exactly like their parents when they first make their appearance in the world and are quite able to take care of themselves in every way—which is just as well, as reptiles do not trouble themselves about their children or feed them as warm-blooded animals do, though they sometimes guard the eggs until the sun has done its work and the babies are safely hatched.

This is one of the largest dinosaur skeletons ever found—but you will have to imagine it as enlarged to a length of some eighty feet.

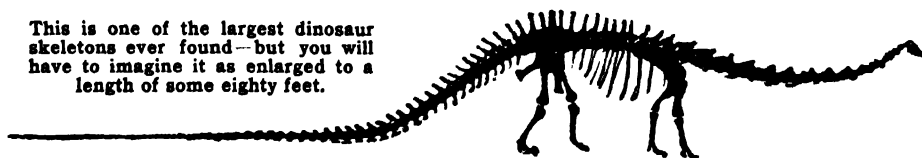


Photo by Carnegie Museum



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# REPTILES

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## Reading Unit No. 2

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### ALLIGATORS AND THE WILY CROCODILE

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

The habits of the crocodile, 3-437-38  
How crocodiles reproduce their kind, 3-439-40  
Why salt-water crocodiles are feared, 3-440

A partnership between crocodiles and birds, 3-442  
How to tell an alligator from a crocodile, 3-443  
How alligators protect their eggs, 3-444

#### *Things to Think About*

Why is the crocodile let alone by other animals?  
How is a crocodile able to stay under water for a long time?  
Why are the crocodiles in India feared by the natives?

In what ways are alligators different from crocodiles?  
How does the female alligator protect her eggs?  
How do alligators spend the winter season?

#### *Picture Hunt*

Why is it hard to kill a crocodile? 3-439  
Do crocodiles ever attack human beings? 3-439  
How is a crocodile born? 3-436  
Why is the Nile River losing its

crocodiles? 3-441  
Has the crocodile a narrow or broad snout? 3-443  
Why are not plovers eaten by the crocodiles in whose mouths they perch? 3-443

#### *Related Material*

In what ways do alligators and crocodiles remind one of dinosaurs? 3-37-39

Did ancient reptiles lay eggs, as crocodiles do? 3-39

#### *Summary Statement*

Crocodiles are fierce reptiles. They can prevent water from entering their lungs and are thus able to drown their victims and eat them at their leisure. Alli-

gators are sluggish and relatively harmless to man. To-day alligators are raised on farms for their hides, from which many useful articles are made.

## ALLIGATORS AND THE WILY CROCODILE

On this page we see what happens when a baby crocodile makes his bow to the world. The egg has been buried by the female crocodile in the warm sand. When she hears the youngsters trying to get out she clears the way.

A. After cracking the shell with its egg-breaking tooth, the little thing pokes its snout through (B).

Then (C) out comes its head—looking laughably like that of some outlandish bird. And last of all (D), out comes the whole funny creature, horny scales, teeth, flapping tail, and all.

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## ALLIGATORS AND THE WILY CROCODILE

This gavial crocodile from the Ganges is by no means the fiercest of his kind, but for all that it would not be pleasant to look too closely at his wicked jaw. Like other crocodiles, he likes to keep his mouth open in a sort of mirthless grin. There is a legend that the old hypocrites weep over the victims they devour.

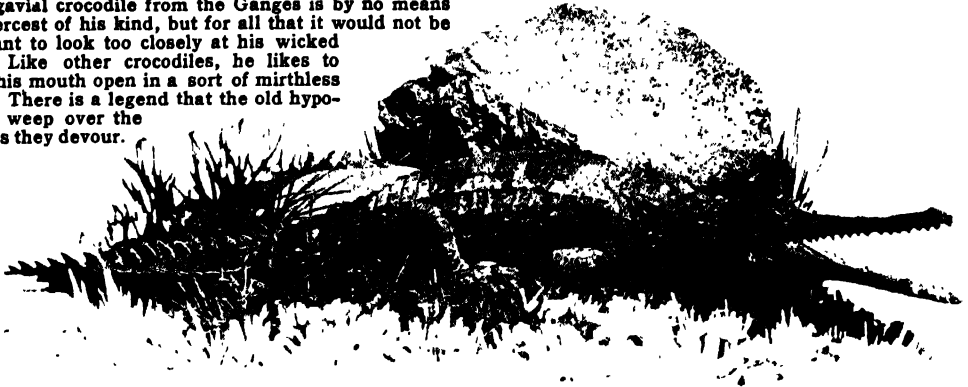


Photo by N. Y. Zoological Society

## ALLIGATORS *and the* WILY CROCODILE

### *Masquerading as a Log, a Crocodile Can Seize and Eat a Man or a Leopard*

**I**N THE rivers, swamps, and dark, silent pools, and along the slowly moving waterways that wind through the forests and jungles of hot tropical countries, live the crocodiles and alligators—the giants of the reptile world. Huge, hideous monsters they are, reminding us more of the gigantic reptiles of past ages than do any other creatures in the world to-day.

You could hardly find anything more truly ugly than an old crocodile dozing on a mud bank on the river's brink—its stumpy legs straddled out on either side and its huge jaws agape, displaying a forbidding array of sharp, pointed fangs.

This is the crocodile's favorite way of spending the day. It will doze in the sun for hours together, if it is not disturbed. In spite of its size and its strength it is a cowardly brute. If anything occurs to startle it, the crocodile hastily dashes for the water, hurls itself in, and disappears out of sight. But in a minute or two, if you look carefully, you will see the tip of the creature's snout and its wicked little eyes just above the surface—the cunning monster is waiting and watching ready to clutch and drag below the water any careless creature that ventures too near.

In the evening the crocodile is wide awake, for this is its regular hunting time. It moves

through the water, swimming close to the banks of the river and keeping a sharp lookout for wading birds and thirsty jungle folk that come down to the water for a cooling drink after the great heat of the day. As they stoop to drink, an ugly head suddenly appears, snap go its powerful jaws, and a helpless victim is seized and dragged beneath the water!

So strong are the crocodile's jaws that it never lets go its victim, however hard the poor thing may struggle. And although it would not willingly attack a powerful beast of prey on dry land, a big full-grown crocodile has been known to seize and drown a young tiger or a leopard that has come down to the water to quench its thirst.

The crocodile is so strong and so well protected against the attacks of his enemies that very few wild beasts, however fierce and bold, care to risk a fight to a finish with the powerful monster. From head to tail tip he is clad in a tough, leathery suit, while his back is shielded by an armor of hard bony plates which defy the sharpest teeth and claws and are almost bullet-proof. A blow from his terrible tail will knock down a horse or a bullock, and sweep a fairly large animal into the water. There the victim is altogether at the mercy of the cunning reptile, who grips it with his jaws

## ALLIGATORS AND THE WILY CROCODILE

and holds the creature down until it is drowned.

The crocodile himself is quite happy and comfortable at the bottom of the river. He is able to stay down below for a long time without inconvenience, and even to keep his mouth wide open without being drowned. This is because at the back of the crocodile's mouth are two valves which can be closed to prevent the water from flowing down his throat. His ears and nostrils are closed too, while a thin film, like a transparent curtain, is drawn over each eye. Through it the strange reptile can see quite clearly all that goes on around him while he is under water.

### How a Crocodile Breathes

Of course after a while the crocodile is obliged to come up to the surface to draw a fresh supply of air into his lungs; for although he spends so much time in the water, he is an air-breathing creature, like other land animals. But the crocodile is able to get his air without putting his head clear out of the water, for his nostrils are placed on the top of a little hump at the end of his snout. So the tip of his nose and his eyes, and perhaps the top of his broad back, are all there is to be seen of the old rascal as he lies and floats at ease in the pool or the river. He might be merely an old log rolling about in the water. Many a poor animal, deceived by his harmless appearance, has found out its mistake too late!

At night the crocodile travels long distances up and down the

river banks in search of food. His feet are used hardly at all in swimming, although the hind pair have webs between the toes; but the long tail serves as a splendid propeller and sends the huge animal rapidly through the water by vigorous side strokes. When he floats near the surface, watching for prey, the crocodile treads water slowly and steadily with his hind feet to prevent himself from being carried down the stream by the currents in the river. So he passes the night, swimming through the water, watching the banks, and making sudden darts at every living creature that comes within reach. When morning dawns, the monster drags his huge body out of the water, flops down on a sand bank or a mud bank, gives a gigantic yawn, and falls asleep with his mouth half open. He sleeps until hunting time comes around again. But before he settles down for his daily nap, the cautious animal nearly always turns himself round with his head toward the water, ready to plunge in at the first alarm.

These reptiles have keen sight and hearing, and they always seem to sleep with one eye—as well as half open; so it is very difficult to take them by surprise when they are in their native haunts.

They are silent creatures as a rule, but sometimes in the night, when everything is quiet, the timid wild

Our pelican seems startled—and no wonder! Who would be able to keep his poise if he saw a face like that suddenly thrust up at him out of his swimming pool? The big bird will be uncommonly lucky if he merely suffers a fright.

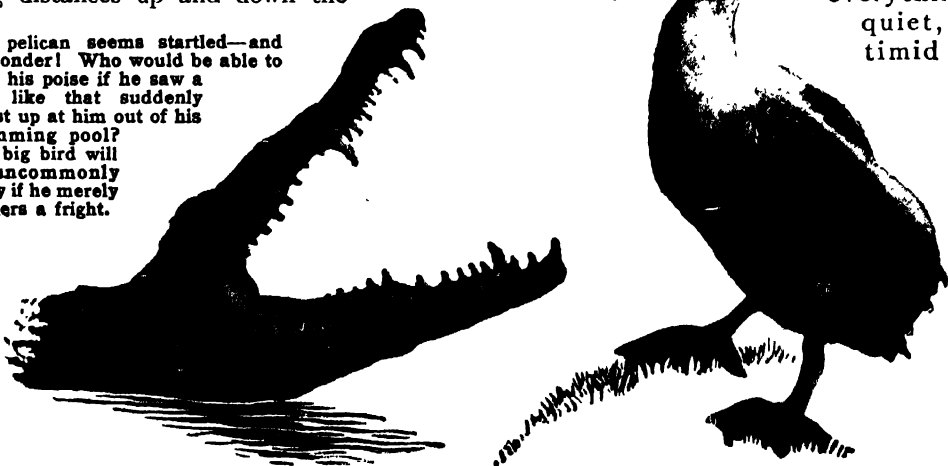


Photo by American Museum of Natural History

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## ALLIGATORS AND THE WILY CROCODILE

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This crocodile is 19½ feet long. The man, you will notice, is aiming at its mouth—the horny armor on its back is almost bullet-proof.



folk round about hear a short, loud bark or a husky croak, which warns them that an angry or excited crocodile is on the warpath and that they had better make tracks for the shelter of the forest, as far from the water's edge as they can go.

### Born Savages

From the very first, crocodiles are fierce, disagreeable creatures. As soon as ever they break their way out of their eggshells, they hiss and snap and lash their little tails, as if they were defying the whole world. The female crocodile chooses a nice dry spot on a bank, near the water's edge, and digs out a big hole about two feet deep with the strong claws on her front feet. In this she deposits from twenty to sixty eggs with hard white shells.



Photo by N. Y. Zoological Society

Then she fills up the hole, smooths the earth over the top of it, and waddles off to take a refreshing dip in the river.

Some crocodiles mount guard over their eggs and go to sleep in the daytime on top of the nest until the time arrives when the young ones are ready to hatch. Then the baby reptiles, who are provided with a hard egg tooth at the tip of their funny little snouts, start chipping away at their shells, making at the same time a queer little noise like a hiccough. When the mother crocodile hears this sound she scrapes away the sand and uncovers the eggs; and soon all the little crocodiles are free and come scrambling out of the hole.

Although the eggs from which they have come are no bigger than turkeys' eggs, the

Many an Egyptian woman, going down to the Nile to draw water or wash her clothes, has been seized in the murderous jaws of the Nile crocodile and dragged to her doom. Or if the creature wants to stun its prey before trying to drown it, one swish of that ringed horny tail will usually do the work.

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## ALLIGATORS AND THE WILY CROCODILE

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young crocodiles are fully eleven inches long when they are hatched. They must have been terribly cramped while they were packed away in so small a space. They are exactly like grown crocodiles—snapping jaws, lashing tails, stumpy toes, and bony armor, all complete. Without waste of time they all troop off to the water, waddling after their mother, who leads the way, with little piping cries of excitement. Cross, quarrelsome little creatures they are, always hissing and snapping and trying to bite everything they see. They begin at once to catch flies and any other insects they can find, and are soon eating frogs and lizards, little fishes, and the small animals that live by the waterside.

### How Long Does a Crocodile Live?

But the disagreeable little reptiles do not have everything quite their own way. While they are still small and weak, vultures and other birds of prey pounce down upon them and carry them off, and beasts from the jungles crunch them up whenever they happen to see them about. They may even be devoured by their own relatives, if they are not careful; for if the silly little things disturb the grown-up crocodiles that are taking their noonday nap, some bad-tempered old fellow is quite likely to snap them up.

Unless an accident happens to a crocodile it may live for more than a hundred years—and go on growing all the time. No wonder some of the old reptiles are so big! All through its life the teeth of the monster are

kept sharp and ready for use, for as soon as its great fangs begin to wear down they fall out in the most convenient way, and there, underneath, are new teeth ready at once to take their place.

### The Fierce Salt-water Crocodile

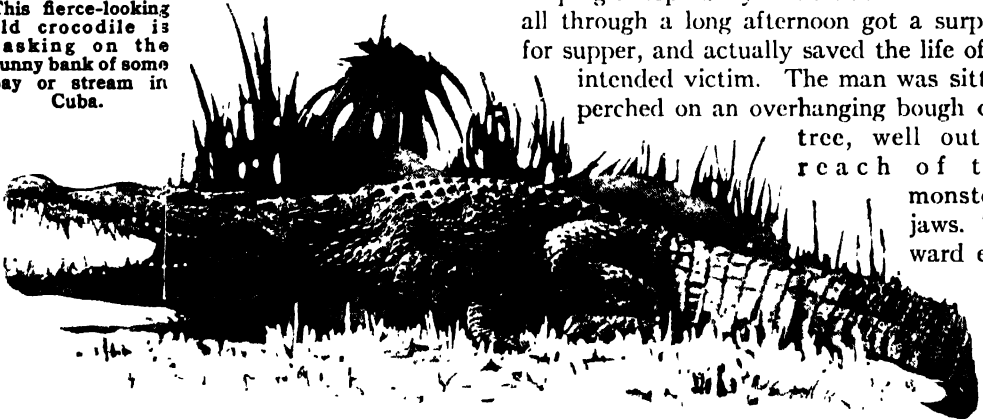
The great salt-water crocodile that lives chiefly in the tidal rivers in India and other countries of the East is one of the largest and most dangerous of its kind. It is a dull greenish-brown color spotted with black, and when full-grown may measure fifteen or twenty feet from the tip of its snout to the tip of its tail. Occasionally a hoary old monster nearly thirty feet long has been seen, but fortunately such a gigantic reptile as this is very seldom to be met.

This salt-water crocodile is a terror not only to all four-footed animals but to human beings as well. It will spring up from its hiding place just under the bank and seize natives who come down to fetch water from the river. It will upset small boats with its lashing tail and snap at the people as they struggle in the water; and anyone bathing in a pool or a stream where one of these creatures is known to lurk does so at his peril.

### The Patience of a Hungry Reptile

Many are the tales told of this giant reptile and its savage ways. It will lie low in the water and watch its prey with horrible patience for hours together, though it is not always rewarded quite in the way it expects. On one occasion an old rascal who had been keeping a hopeful eye on a native fisherman all through a long afternoon got a surprise for supper, and actually saved the life of its intended victim. The man was sitting perched on an overhanging bough of a tree, well out of reach of the monster's jaws. Toward eve-

This fierce-looking old crocodile is basking on the sunny bank of some bay or stream in Cuba.



## ALLIGATORS AND THE WILY CROCODILE

ning rain came on. So to shelter himself the man covered his head and shoulders with a large sack and quietly went on fishing. Suddenly a leopard sprang out of the jungle and leaped at the man. But the beast missed its mark, grabbed the sack, and with a mighty splash fell into the river right into the jaws of the hungry crocodile!

### How Crocodiles Migrate

In Ceylon and China, in the East India islands, and in North Australia, as well as

The days when this crocodile can lord it over the other creatures along the Nile are over. His captors have set a trap for him—a noose fastened to a tree. They were careful to put it where he usually passed on his nightly rounds. This morning they found him tugging indignantly at the stout rope—but it held him tight. Then his human enemies could either kill him or send him off unharmed to some zoo.



taking a nap on a sunny bank, the huge reptile is much upset and bolts for its watery home in a tremendous hurry. Once in the river it quickly sinks out of sight, and only its two green, catlike eyes and the lump at the end of its long nose mark the spot where the wily gavial is hiding.

Although he is neither so big nor so dangerous as his salt-water cousin, the Indian marsh crocodile, or the "mugger," as he is usually called, is a bad-tempered, vicious creature. He is rarely more than

twelve feet long and is naturally so timid that he heads for the water as soon as he sights a man. But it would never do to take liberties with an old mugger.

all along the east coast of India, this huge, vicious reptile haunts the mouths of the rivers, the salt marshes, and the brackish streams. It is even seen occasionally swimming strongly far out to sea. In this way, no doubt, the great crocodile sometimes migrates from one country to another.

The gavial (gā'vī-äl), or "long-nosed crocodile," is another huge Indian reptile. It sometimes grows to a length of twenty feet and is distinguished by having an extraordinary long, narrow snout with a lump at the top, which looks absurdly like the handle of a frying pan. Although it is so big and strong and its queer jaws are armed with terribly sharp teeth, the gavial is not really a dangerous animal. It feeds almost entirely on fish and never attacks man or large animals. It is a strange, solitary creature, spending most of its time in the dark waters of the Ganges and other muddy Indian rivers. If anyone disturbs it when it is

He is rather a stupid fellow. Once when overtaken in the jungle by a man on horseback, one of these crocodiles rushed full tilt for a pool which was almost dried up and stuck his head in the mud. There he stayed, perfectly still, under the impression, perhaps, that he was completely hidden from view—although his great body and long tail were plainly to be seen sprawling on the bank!

### When Muggers Go Wandering in the Jungle

Muggers venture much farther inland than the salt-water crocodiles, and sometimes in the dry season, when their pools disappear, they journey long distances on foot through the jungles. At such times they occasionally make their appearance in the towns and villages, where they wander about the streets, fall into wells, and crawl into gardens for a nap. But although they may snap up a stray chicken or two, the muggers are usually too much frightened at

## ALLIGATORS AND THE WILY CROCODILE

Here are an alligator and a crocodile—can you tell which is which? The alligator, on top, has a broader, more rounded snout. If we were looking at the crocodile from the side, we could see some of his teeth, even when his mouth is closed.



finding themselves in such strange surroundings to do much harm.

Photo by N. Y. Zoological Society

In some parts of India large numbers of muggers are kept by the natives in huge ponds or tanks. Since they are regularly fed with fresh meat, the crocodiles are quite contented there, and grow so fat and lazy that they can hardly waddle. Although you could scarcely call them "tame," the muggers never attempt to snap at the people who visit them. The Hindus walk about among them, as they lie panting on the banks, without the slightest fear; they even bow low before the gaping jaws of some hideous old monster, who is much too dull and lazy to take any notice of the respectful salutation.

### The Sacred Crocodile of the Nile

The crocodile of the Nile is one of the most famous of its tribe, and in olden times it was worshiped by the ancient Egyptians. Judging from the enormous number of mummies of the unattractive reptiles that have been preserved, the waters of the Nile must have been alive with them in bygone days.

But the old tyrant of the Nile has fallen from its high estate. No longer is it treated with reverence. It is killed without mercy on account of its savage ways, and has been practically banished from its old haunts in Lower Egypt, though it still makes its home in the upper reaches of the Nile. It is fairly abundant, too, in all the African rivers from

Egypt down to the Cape of Good Hope; and in the inland rivers of Madagascar it is only too well known.

Though not quite so gigantic as the salt-water crocodiles of India, the African crocodile is just as ugly and ferocious. It is a terrible danger to bathers and the terror of all wild creatures who live near the banks of the rivers, for it will seize and crunch up any living thing—fish, bird, or beast—that comes its way.

Yet, strange to say, the Egyptian plover, a lively black and white bird that haunts the banks of the Nile, is not at all afraid of the great reptile. The bold little bird will sit on the crocodile's head, as it basks in the sun, actually walk in and out of its open mouth, and pick its teeth without coming to any harm! You see the crocodile is much worried by water leeches that cling to its gums and make it very uncomfortable. The bird removes the annoying things—and because its services are so useful, the old reptile refrains from gobbling it up.

### A Queer Entrance to a Dining Room

These crocodiles often dig out tunnels thirty or forty feet long in the banks of the river. The entrance is always below the water level, but at the farther end the tunnel widens out into a dry, roomy compartment, large enough for the creature to turn itself round in. The crocodiles bolt into these burrows if they are attacked when they are in the water; and, judging from the number of bones that have been found there, they



## ALLIGATORS AND THE WILY CROCODILE

also use the underground chambers as dining rooms, where they can enjoy their meals undisturbed.

The American crocodiles are very much like their Old World cousins—just as ugly, just as cross, just as savage, but fortunately not quite so huge as the giant crocodiles of Africa and Asia. They are quite big enough. In the New York

that feed and rest on the banks of streams and rivers.

In their looks and in their habits the American alligator and the crocodile are very much alike. But if you look at the two creatures side by side you will see that the crocodile has a pointed snout, somewhat the shape of a triangle, while the alligator's snout is broad



### Zoological

Park you may see wicked-looking monsters twelve feet long which have been captured in the rivers along the coasts of Central and South America. No matter how long they are held captive, they never grow tame, but are always ready to snap at a keeper or knock him down with a swish of the tail if he is careless enough to give them an opportunity. You can never trust a crocodile!

### How to Tell an Alligator

Many big crocodiles have been captured in the south of Florida, but as these reptiles cannot live in cold water they are seldom found farther north. The Orinoco crocodile makes itself at home all along the Orinoco and its tributaries. Since it will occasionally seize a native as he stoops to draw water from the river, it is cordially disliked there. But after all it is not very bloodthirsty. It lives chiefly on fish and the small wild beasts

To see these saucy little plovers using the crocodile's jaws as a perch and a dining table, you would never suppose him to be so fearsome a beast. It is hard to guess how he knows it is to his advantage to let them go uneaten.

and blunt and rounded at the tip. A crocodile, as a rule, has larger teeth than an alligator, and it shows them more, too. When the crocodile closes its jaws, the two great fangs in the lower jaw fit into notches outside the upper one and so are still plainly seen, but the alligator's fangs are out of sight when its mouth is shut.

The alligator is altogether a more ponderous, bulky person than the crocodile; it is not so quick and active, and is much less dangerous to encounter. The keepers in the New York Zoological Park actually walk over the backs of the old 'gators when they clear out the swimming pool, but they would never dare to take such a liberty with the crocodiles.

Although an alligator will never willingly attack a man, it will put up a good fight if it is cornered; and with its great teeth and lashing tail the beast is a forbidding enemy to tackle. Alligators fight among themselves,

## ALLIGATORS AND THE WILY CROCODILE



Photo by Nature Magazine

Alligators have much better dispositions than crocodiles, and are too lazy to attack a man unless he starts the fight. On this Florida alligator farm it is perfectly safe to walk among the sleepy 'gators—or even to ride one as you would ride a horse. The horny steed

in this picture is named Ocklawaha. He is the largest alligator in captivity—13½ feet long—and is said to be eight hundred years old.

too, when they are looking for their mates. In the early summer months their loud, bellowing roars, which sound rather like the mooing of cows, may be heard at night in the swamps and lagoons of Florida and Georgia. But at other times alligators are lazy, lumpy animals. They love to wallow in shallow pools or lie flat on the muddy banks by the waterside and doze away the sunny hours. They do not like salt water and live farther inland than crocodiles do, preferring quiet pools and streams in the heart of wild, wooded country, where they are not likely to be disturbed.

### A Nursery for Young Alligators

Mother alligators make large mounds of wet leaves, moss, and twigs to protect their eggs, which are buried in the mass of rotting

stuff. This nest is two or three feet high and measures about five feet across. It usually contains from twenty to thirty hard-shelled eggs. A mother alligator does not stray very far from her nest while her eggs are hatching; and when the young ones appear she usually shows them the way down to the water. But after that she takes no interest in her children. The little alligators go their own way, and are quite able to take care of themselves.

### How Alligators Spend the Winter

When winter is near, the alligators dig caves in the muddy banks of the pools or streams. There they stay in a stupid, torpid state until the following spring, when they wake up and crawl out into the world again.

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## ALLIGATORS AND THE WILY CROCODILE

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Photo by N. Y. Zoological Society

**These alligators and crocodiles at the New York zoo have piled themselves up three deep in an effort to**

**get a place in the sun. For these tropical creatures dearly love to feel the sun's fiercest rays.**

The only alligator of the Old World is found in China, where it haunts the banks of the Yangtse-kiang River. It is very much like the American species, but is smaller, never growing more than six or seven feet long, while its American cousin is often as much as ten or twelve.

In South America the place of the alligator is taken by the cayman. There is not much difference between the two reptiles, but the cayman has a sharper snout and wears a bony coat of mail all the way round its body, instead of being armored only on its back.

The spectacled cayman, which ranges from Mexico through Central America to

the Argentine, is about eight feet long. It takes its name from its queer wrinkled eyelids that make it look as if it were wearing a pair of spectacles. It moves more quickly than an alligator and is a bad-tempered beast, always ready to snap and show its very long, sharp teeth.

The black cayman of the Amazon River is the largest of its tribe. It is said to grow sometimes to the gigantic length of twenty feet, and is remarkably broad and stout as well. In the wet season the cayman will often leave the river and wander about the flooded forests, while in hot, dry weather it sometimes buries itself in the mud until the rains return.

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# REPTILES

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## Reading Unit No. 3

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### LIZARDS OF EVERY SHAPE AND SIZE

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

- |   |  |
|---|--|
| The different kinds of lizards, 3-447-48  | The gecko with a parachute, 3-450            |
| Lizards that drop their tails, 3-448      | Lizards that like to stay in water, 3-451-52 |
| Why geckos can walk on the ceiling, 3-448 | Habits of iguanas, 3-451-53                  |

#### *Things to Think About*

- |   |  |
|---|--|
| Why can lizards escape even when they are tightly held? | What lizard spends a good deal of time swimming? |
| How are geckos adapted to climbing on smooth walls?     | What legends are told about ancient "dragons"?   |

#### *Picture Hunt*

- |   |   |
|---|---|
| What kind of skin has a lizard? 3-447, 449, 450       | covered with spines? 3-450                                  |
| What unusual features has the gecko? 3-448            | What use does one kind of lizard make of its "beard"? 3-449 |
| What lizard tribe contains the largest lizards? 3-451 | How do lizards get out of their eggs? 3-452                 |
| Why is the spike-tailed lizard                        | What lizard is used by man for food? 3-453                  |

#### *Related Material*

- |  |  |
|--|--|
| What relative of the lizard also uses an "egg tooth" in order to get out of its eggshell? 3-439-40 | get out of eggs? 4-96                                    |
| What animals besides reptiles have egg teeth which help them                                       | Which lizard has lost its legs? 3-458-59                 |
|  | Which lizard in the United States is poisonous? 3-458-59 |

#### *Summary Statement*

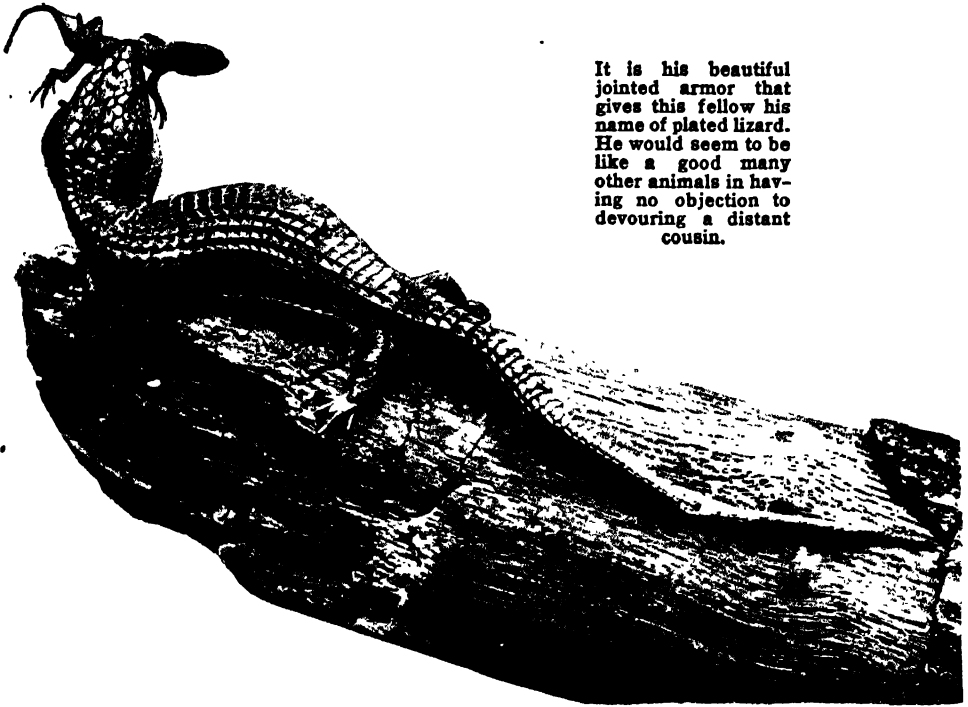
Lizards are reptiles. Many are able to escape an enemy by pinching off their tails. Later, their tails grow again. Some lizards are armed with strong spines and some are protectively colored. A few prefer the water, though most of them live in trees.

Geckos have suction pads on their toes which help them to climb walls or to walk on windows and ceilings. As a rule, lizards are completely harmless, and one kind is even eaten by natives in the tropics. Certain species are very beautifully colored.

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## LIZARDS OF EVERY SHAPE AND SIZE

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It is his beautiful jointed armor that gives this fellow his name of plated lizard. He would seem to be like a good many other animals in having no objection to devouring a distant cousin.

Photo by Raymond L. Ditmars Courtesy American Museum of Natural History

## LIZARDS *of* EVERY SHAPE *and* SIZE

*They May Be as Big as a Crocodile or as Tiny as Your Thumb, and They Have Learned to Live in Trees, in Sand, or in the Water*

**I**F ALL the different lizards in the world—just one of each kind—could be gathered together to-day in the same place, we should have an astonishing collection of creatures. No less than nineteen hundred of these reptiles have been described in various natural history books, and for all we know there may be still others living in desolate spots that no one has ever seen.

Among the crowds of scaly creatures which together make up the great lizard tribe are reptiles of all sizes, colors, forms, and habits. There are giant lizards nearly as big as crocodiles, and tiny things no bigger than your thumb. There are lizards with crests and scaly tails like the fabulous dragons of old; there are others with frills, horns, or fringes which make them the strangest of

objects; and some are studded with thorns and spikes. There are sand lizards, rock lizards, tree lizards, and water lizards; lizards that crawl slowly and laboriously on the ground; lizards that dash along with the speed of a racing car; and a few lizards that may almost be said to fly. While the majority of these reptiles have four short, sturdy legs of much the same type as a crocodile's legs, some have only two, and others have no legs at all and are obliged to wriggle about as snakes do.

Many of the smaller lizards are most graceful and charming little animals, with eyes like glittering jewels and smooth, polished coats of bright green or blue or changing colors. Others are marked with spots and stripes in all sorts of wonderful ways. These little lizards make delightful pets and

## LIZARDS OF EVERY SHAPE AND SIZE

are very lively and amusing if they are fed properly and kept comfortably warm. But all lizards are dull and torpid if they are cold, and will not feed unless they are kept in a high temperature. So the poor little things will quickly die if their ways are not understood. You have to be very careful, too, how you handle a lizard, for if it is startled, it will probably dash away and leave its tail in your hand! Most of the small lizards have this uncomfortable habit. And a very useful one it proves, too—when the otherwise defenseless little reptiles are in danger of being caught by one of their many enemies.

For some time after it is broken off, the tail continues to wriggle and twist about all by itself in the most surprising way, and this on many occasions saves the life of its owner. Suppose, for instance, a bird pounces down upon one of the lively little reptiles and catches it by the tail. With a quick jerk the lizard snaps it off, and before the bird discovers that the writhing thing he has in his beak is just a tail and nothing more, the lizard makes a dash for cover and is completely out of sight.

It is, of course, the working of the muscles that causes the discarded tail to behave in so strange a way. If the bird drops the uncanny thing instead of eating it, the wriggles and jerks will gradually subside until at last the tail lies quite still upon the ground.

The loss of its tail is no very serious matter to the lively lizard, for a new one starts

growing almost immediately. In a few months' time the new tail will have grown to a fair size, although it never gets quite so long as the old one. Sometimes, instead of one new tail, two or even three will sprout from the broken stump. The lizard looks as if it were some strange new invention in reptiles.

Big lizards do not fling away their tails in this reckless manner. They use them as weapons of defense and with them deal stunning blows at their enemies, much as crocodiles do.

The geckos—a large family of quaint little lizards—are all noted for their extremely brittle tails. There are about three hundred different species of geckos distributed over almost all the warmer parts of the globe; but they are most common in India, the Malay States, and in Australia.

Geckos cannot be called handsome. They are mostly plump little crea-

tures with flat heads and thick, stumpy tails, clothed in a dusty-colored, toadlike skin—though many are ornamented with spots of various shades.

There are one or two peculiar things about these little

reptiles. In the first place, unlike other members of the lizard tribe, they have no eyelids, or have only traces of them; their glittering, catlike eyes are protected by a transparent cap like a tiny watch crystal. Then their tongues are thick and sticky, but can be shot quite a long way out of their mouths. The geckos find them very useful

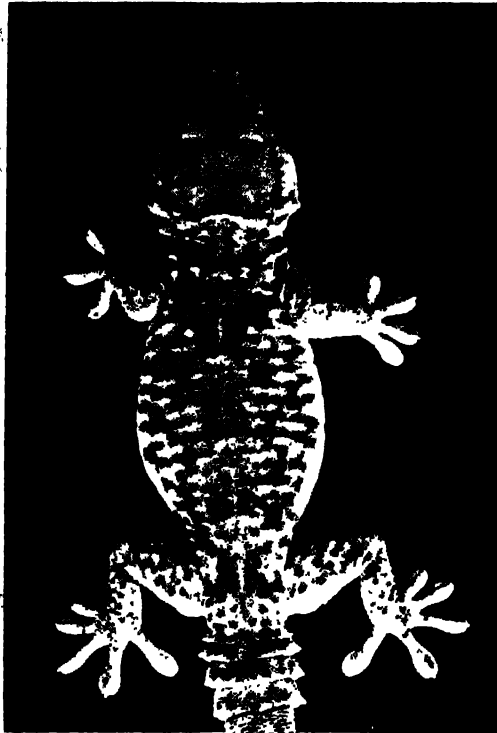


Photo by N. Y. Zoological Society

This is one of the lively little geckos, the only lizards with voices. You can see his curious toes, provided with vacuum pads that make it possible for him to run up a wall or a windowpane.

## LIZARDS OF EVERY SHAPE AND SIZE

for mopping up flies and other insects on which they feed. But strangest of all are the feet of these queer little lizards. At the tip of each toe is a most convenient set of overlapping vacuum pads, which enable the creatures to run up a wall or a window-pane, or dart upside down across a ceiling as easily as flies do. In addition to these accomplishments the geckos are distinguished from all other lizards by having a voice. When they are running about excitedly, hunting beetles and cockroaches or calling to one another, the lizards make a shrill clicking noise which sounds somewhat like "Yecko! Yecko!" You can mimic this sound very nearly by clicking your tongue against the roof of your mouth.

### Fables of the Gecko

Most of the geckos live in trees or among the rocks; but in eastern countries they often swarm in the houses. Some kinds take up their abode in cellars, others settle themselves among the rafters, and yet other families occupy cracks and chinks in the walls. In the daytime the geckos always keep to their own particular part of the establishment, and remain quietly tucked away in their hiding places until daylight fails. But at night they wake up and run about all over the house, dashing up and down the walls, scampering over the ceilings, and crying, "Yecko! Yecko!" as they hotly pursue insects which, like themselves, turn night into day. But when the hunt is over, and the geckos have finished feeding, they all retire to their own private apartments to sleep until evening comes again.

In destroying so many insects, which are a terrible nuisance in eastern lands, the geckos are really useful; yet in Africa and Arabia these little lizards have a bad reputation, which they

do not in any way deserve. The natives firmly believe that a deadly poison oozes from the suckers on the toes of the harmless little things, and solemnly declare that they can bite so hard that their little teeth make dents in steel. Of course there is no truth in either of these fables. The geckos' toes are not poisonous and their teeth are so small and weak that even if they try to bite you they hardly make any impression on your skin.

### Lizards No Bigger than Insects

The largest and handsomest of the gecko family is found in Southeast Asia. It is really a fine lizard fourteen or fifteen inches long and is dressed in a smart blue scaly coat ornamented with large round orange spots. This gecko lives in trees and feeds not only on insects but on mice and small birds that it is said to steal from their nests.

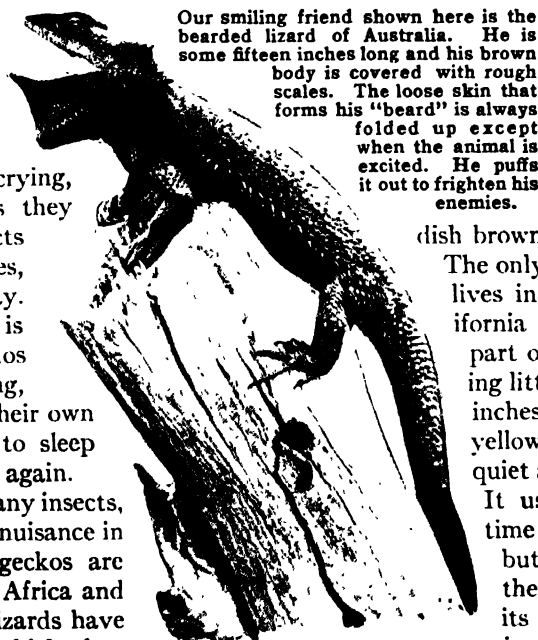
There are a number of geckos in tropical America, and several tiny species hardly two and a half inches long in Central America and the West Indies. Some, indeed, are so small they might easily be mistaken for insects. These little lizards often hide under the eaves of the house during the heat of the day and come out in the cool of the

evening in quest of the small insects on which they prey. Some of the tiny reptiles are quite pretty little things, with speckled or banded coats of red-

dish brown which look very smart.

The only North American gecko lives in rocky districts in California and the southwestern part of Texas. It is a charming little creature three or four inches long, with a brown and yellow coat, and it is very quiet and retiring in its ways.

It usually spends the daytime in a chink in the rocks, but late in the afternoon the gecko comes forth from its hiding place to hunt for insects for its supper.



Our smiling friend shown here is the bearded lizard of Australia. He is some fifteen inches long and his brown body is covered with rough scales. The loose skin that forms his "beard" is always folded up except when the animal is excited. He puffs it out to frighten his enemies.

Photo by Presse-Photo

## LIZARDS OF EVERY SHAPE AND SIZE

Among the three hundred species of these quaint little lizards are many so much alike that there is very little difference between them. But some members of the gecko family are more original and have developed fringes on their toes and tails, and a few have eyelids like other kinds of lizards. One branch of the family has taken to a life in

branch in quest of insect prey, its "wings" are folded up like fans and held close against its sides. But if the lizard wishes to change its hunting ground, it suddenly spreads its fans, launches itself into the air, and makes a gliding flight to another tree, much as flying squirrels do—its so-called wings acting as parachutes.

Why this lizard should be called a "dragon," one really cannot say—unless, since it can take short trips through the air, it was named

after the gigantic flying dragons that lived on the earth so many long ages ago. But flying lizards are not in the least like those terrible reptiles of bygone days. They are graceful little animals and their "wing fans" are often as bright and beautiful as the wings of a butterfly. As they glide from

The Mexican dragon lizard, shown in the oval, has a tail so long that it had to be left out of the picture. If you multiply the length of his body by four, you will just about have the length of his tail.

the deserts, where they have lost their suckers and have grown, instead, little scaly projections on each side of their toes. These prevent the lizards from sinking into the fine shifting sand. Yet another gecko of the East Indies has actually taken to flying—or rather we should say to gliding, for it is really no more than this. On each side of its body is a wide flap of skin. This the lizard uses as a kind of parachute to hold it up as it takes long, flying leaps from one tree to another.

But the flying dragon, which lives in the same quarter of the globe, has advanced a step further in aerial locomotion. It has actually a pair of "wings" formed of two folds of skin supported by six or seven ribs which project on each side of its body. When the little creature is running over the trees and jumping lightly from branch to

sects; and even the larger ones nearly a foot long, are so slender that they look much smaller than they really are.

There is really nothing about the little flying dragons to frighten anyone; but some of their near relatives would be most alarming creatures if they were not too small to be dangerous. The spiny lizards of Australia, or "thorny devils," as they are often called, are most fearsome-looking objects, covered from head to tail tip with sharp spikes and



Photos by N. Y. Zoological Society

In the square is a view of the amazing array of spines on the spike-tailed lizard.



## LIZARDS OF EVERY SHAPE AND SIZE

thorns. Even their legs are all prickles, while two particularly big thorns project from their eyebrows. Yet thorny devils are perfectly harmless. They are small, rather feeble lizards not more than six or seven inches long; but their prickly armor is no doubt useful in making other creatures keep at a respectful distance. They feed almost entirely on ants. These they pick up one by one with their long sticky tongues, which flash in and out of their mouths so quickly you can hardly see them. How many ants a thorny devil can eat at a single meal, it would be hard to say.

### A Lizard with a Fancy Collar

But stranger still—and much more alarming in appearance—is the extraordinary frilled lizard, which also lives in Australia. It is a good deal bigger than the flying dragon and the thorny devil, and is distinguished from all other lizards by the large frill of many colors that it wears round its neck. When the lizard is resting or running about up and down the trees on which it lives, this frill is folded in neat pleats and spread over its shoulders. But should it be startled or annoyed, the frill springs up and stands out round its head like a suddenly opened umbrella. At the same time the lizard opens its mouth wide, shows its sharp teeth, and hisses like a little fury. Such a sight is enough to scare the boldest creature; even hunting dogs, who will fearlessly attack much larger and more dangerous animals, back away from an an-

gry frilled lizard and refuse to go near it.

When it is up in the trees this lizard runs about on all fours—like other members of its tribe—but when it is on the ground it often rears itself up on end and runs off very fast on its two hind legs. It is one of the funniest of sights to see this odd little creature speeding along at a bold, swinging gait, with its front legs hanging down like arms, its big frill flopping on its shoulders, and its long stiff tail wagging from side to side.

### This Lizard Lives in the Water

The frilled lizard is not the only one of its tribe to behave in this unusual way. An Australian water lizard that lives in the scrub near river banks is also fond of walking about on its hind legs when it is on dry ground. It is one of the few lizards that enjoy bathing, and it spends a good deal of time in shallow water, swimming about quickly and gracefully swishing its tail from side to side.

The Mexican iguana may be over a yard and a half long, but at least two-thirds of his length goes to a handsome tail, with which he can swim very well. All along his back is a crest of elevated scales. He possesses a pair of eyes, but seems to have been caught napping.

Some of the iguanas (i-gwā'nà), too, will rise up on their hind legs occasionally and run about like a bird. Iguanas are large, stout lizards, some quite handsome in their way, while

others are most ugly-looking creatures. With the exception of a few of their relatives who live in Madagascar and the Fiji Islands, all the

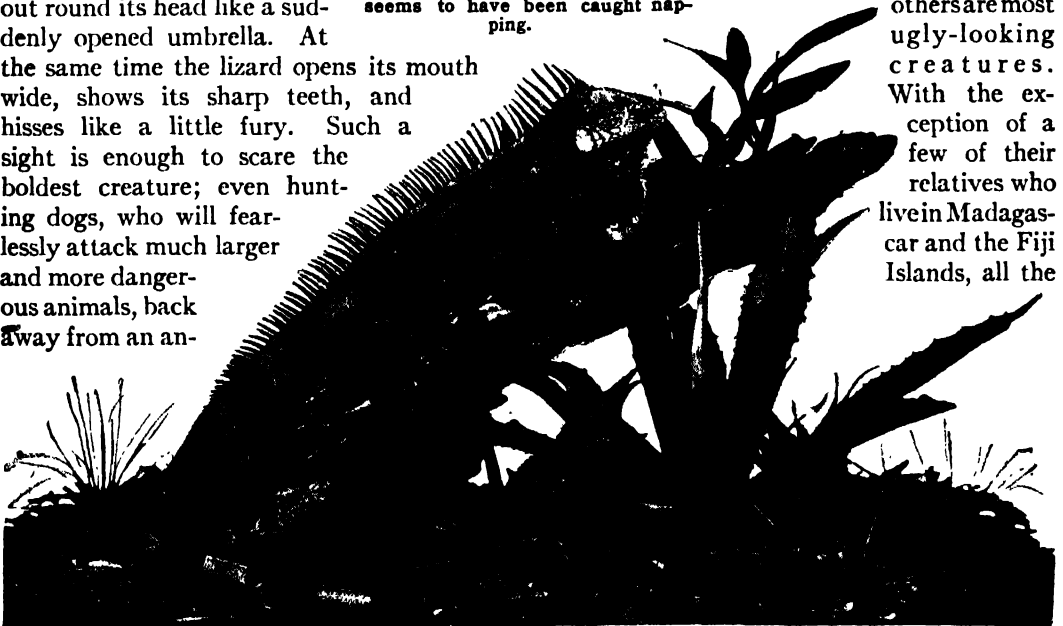


Photo by American Museum of Natural History

## LIZARDS OF EVERY SHAPE AND SIZE



Photo by American Museum of Natural History

These are four baby rhinoceros lizards caught in the very act of hatching out. In many kinds of lizards the unhatched infant has a sharp "egg tooth" on his

snout. He uses this to break his shell, and then loses it in a few days. Most reptiles with teeth have an endless succession of them, not two sets only.

true iguanas are natives of America and the West Indies. The common iguana of tropical and Central America is a big, heavy animal, sometimes as much as six feet long from its nose to the tip of its tail. It is a pale greenish-gray color, usually marked with black, and round its tail are several broad black rings. Under its chin the lizard has a large baggy pouch of skin, while running down its back from the top of its head is a crest of long leathery spines, which looks amusingly like the fringe on the headdress of an Indian brave.

Although they are such big things, these lizards live up among the branches of the trees, particularly on those that overhang the streamwinding through the South American forests. They are fond of sprawling on the boughs with their legs hanging down on each side. There the lazy creatures will lie, doing nothing at all for hours together unless they are startled. Then they nearly always fall off their perches "plump" into the water; and travelers making their way along the narrow forest creeks are some-

times startled by a shower of iguanas falling on their heads!

Although these lizards catch and eat rats and mice and young birds whenever they can, they live chiefly on the leaves and fruit and berries they gather from the trees. They are very fond of some kinds of flowers, too. If next time you visit a zoo you take the iguanas a bunch of chrysanthemums, a dahlia, or even a dandelion, you will give them a real treat.

There are so many of these New World lizards that we shall have time to notice only one or two of them. The sea iguana, which lives in large flocks on the coasts of the Galapagos Islands, is a big, sulky-looking brute in a dark brown

or blackish scaly suit. It is quite harmless, though it does look so disagreeable. It crawls lazily over the masses of lava on the shores of the islands, and feeds chiefly on seaweed.

The black iguana of Mexico and Central America is a big lizard with a spiked tail that it uses for lashing out savagely at anyone who interferes. But the creature does not want to fight if it can be avoided.



Photo by N. Y. Zoological Society

This dainty little thing is a desert iguana.

## LIZARDS OF EVERY SHAPE AND SIZE



Photo by American Museum of Natural History

Here is a family of rhinoceros iguanas at play. Like the rest of the iguana tribe they have a crest of long slender scales all the way down their backs; and this particular species has horns besides. Iguanas are almost entirely confined to the New World, where the

common iguana grows to be as much as six feet long. It lives in the tropics and makes its home in trees, where its brown and green coloring is a good protection. But that does not prevent the natives from hunting it out, for its flesh is very good eating.

If disturbed when it is sunning itself on a tree trunk or a rock in an open forest glade, it will make a dash for cover and plunge through the tangled undergrowth of the trees, making nearly as much noise as a young bull.

The handsomest of these lizards is the banded iguana of the Fiji Islands. It is really a beautiful creature, with an extraordinarily long tail fully twice the length of its body. Tail and all, it measures about a yard. The male iguana is a pale bluish gray banded with the lightest emerald green, but the female of the species is not quite so smart, for she is dressed entirely in pale green.

### The Odd-looking "Rhino"

The rhinoceros iguana is a decidedly odd-looking reptile. It has a big heavy head, a large hanging throat pouch, and three horns on its snout, just like the nose horns of an old "rhino." It has, too, a peculiar habit of "sitting up," supported on its sturdy front legs, while its back legs lie flat upon the ground. In this position the lizard will often remain for quite a long time—so still that it might be some strange Chinese monster carved in stone.

Still more curious is the famous basilisk (*bās'y-lisk*) of Central America and Mexico. It is a fairly large lizard, with a high crest which stands up like a fin on its back and

extends half way down its long tail, while another crest, like a tall peaked cap or a cock's comb, adorns the top of its head.

This lizard is called a basilisk after an imaginary monster of the same name that was supposed to exist in olden times, when people firmly believed that dragons and ogres and all sorts of terrible monsters prowled about the world. So fearsome was the reptile believed to be that it was said to poison the air all round it and to strike all living creatures dead with a glance of its eye! All, that is to say, except the rooster, who defied the horrible basilisk and by his loud crowing forced the monster to flee and hide itself in the desert.

But there is nothing terrible or alarming about the real basilisk. It is not poisonous, and it is really much more harmless than many of the smaller lizards. It lives, like its cousin, the common iguana, up in the trees by the side of rivers and creeks; there it climbs and bounds about as nimbly as the sprightly little tree lizards do. If it is frightened, the basilisk nearly always takes a header into the water, where it paddles about with its head and neck held high above the surface, using its front legs as oars and its long scaly tail as a rudder. The lizard is such an accomplished swimmer that in some parts of the country it is called the "ferryman."

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# REPTILES

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## Reading Unit No. 4

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### STRANGE LIZARDS OF MANY LANDS

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Lizards that change color as you watch them, 3-455  
How chameleons may be kept at home, 3-456  
The lizard that looks like a toad, 3-457

An American lizard whose bite is deadly, 3-458  
Lizards that lost their legs, 3-458-59  
Giant lizards as big as a man, 3-460-61

#### *Things to Think About*

What American lizards can change their color?  
Why must the Gila monster of Arizona be left strictly alone?  
Why is one lizard called a "glass snake"?  
How large are the "Komodo

dragons"?  
Of what use to a chameleon is its ability to change color?  
What lizard living to-day is believed to be the last survivor of prehistoric reptiles?

#### *Picture Hunt*

How does a monitor lizard defend itself? 3-455  
What style among women once made the chameleon very unhappy? 3-456  
What kind of skin have lizards? 3-457  
How has nature provided for the

horned toad's protection? 3-458  
What two lizards are known to be poisonous? 3-459  
What lizard seems to have two heads? 3-460  
What do Komodo dragons remind you of? 3-462

#### *Summary Statement*

Lizards show tremendous variation in size. Some are a few inches long while others may grow to a length of twenty feet. The chameleons fascinate us because they change color according to their background. When at-

tacked, some lizards, such as the swifts, resort to speed; others, like the monitors, can deal a heavy blow with their large tails. The horned toad squirts blood out of its eyes at an enemy.

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## STRANGE LIZARDS OF MANY LANDS

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Nature would seem at one time to have had high ambitions for the lizards, and to have made them of enormous size. But for some reason she changed her mind, and has been making them smaller of late. The monitors are now the largest of the tribe. They may often weigh over sixty pounds. They do not snap their tails off, as many other lizards do, but use them as striking weapons, with which they can knock a man down.

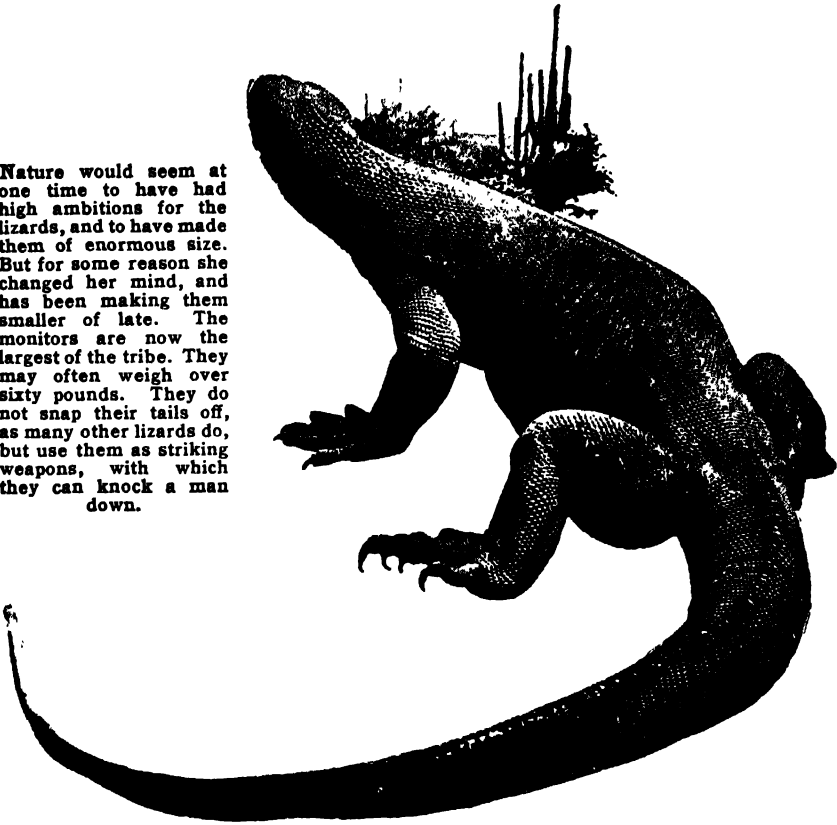


Photo by N. Y. Zoological Society

## STRANGE LIZARDS *of* MANY LANDS

*Some Are as Beautiful as Jewels, Some Can Change Color  
While You Look at Them, and Some Take in a  
Little Bird to Share Their Quarters*

**I**T IS amazing to see how many animals have developed strange tricks. A number of really beautiful little Anolis (ă-nō'lis) lizards make their homes in the forests, groves, and gardens of all the warmer parts of America. They are sometimes called alligator lizards because they have such very big heads in proportion to their slim little bodies; and sometimes they are called chameleons (kā-mē'lē-ŭn) because, like certain Old World lizards, they have a surprising way of changing the colors of their bright scaly coats to suit the particular occasion. Some of these little creatures are a lovely glistening green with a

silvery white waistcoat. But even while you are admiring them, they may turn to some shade of brown or gray or yellow. This change comes about when they are frightened or angry, or it may be caused by different effects of light and shade. Most of the male chameleons have bright red or yellow throat pouches, which they spread out like fans whenever they are excited.

### The Graceful Chameleon

These pretty lizards are most lively little creatures. They scramble up and down the trees and jump from bough to bough like tiny squirrels, with hardly ever a fall. They

## STRANGE LIZARDS OF MANY LANDS

run nimbly along walls or fences and enter houses with the greatest impudence to hunt for something to eat; and since they kill flies, gnats, and wasps, as well as spiders and scorpions, the bold little visitors are always welcome. With eyes glittering the lizards move cautiously nearer and nearer their prey. They are like a cat stalking a bird. Then with a sudden pounce they spring upon their victim, and very seldom miss their mark.

### They Leave Their Tails Behind Them

The male chameleons are often very quarrelsome, especially in the springtime, when they are choosing their mates, for they are then exceedingly jealous of one another. If a smart little fellow meets a rival, he at once challenges him to fight. The two furious little creatures spread their bright throat fans, nod their heads violently, and dance toward each other with funny little mincing steps. Then with a sudden rush they spring together and roll over and over, clawing and biting until one of the combatants has had enough of it and dashes away leaving his tail behind him.

These little lizards are able to run straight up walls or even panes of glass, for underneath their toes they have small pads which enable them to cling to smooth surfaces. But such pads are not quite the same as the overlapping vacuum pads on the toes of the funny little geckos.

American chameleons will live quite happily in captivity if they are properly treated, but they must be kept comfortably warm. They must have tree branches to run about on and be given plenty of meal

worms and flies to eat; and their cages must be regularly sprinkled with water so that the little creatures may lap up the drops. For when these lizards are at liberty they always quench their thirst by sipping the dewdrops on the leaves of the trees; and it is no good giving them water in a pan, since they will not touch it.

A whole troop of bright little lizards called swifts are scattered about the western states of North America and in Central America. You will understand why they are so named if you try to catch one of the lively little creatures, for they whisk about so fast you cannot even clutch one by the tail.

### Where the Swifts Play

Although they can dart up a tree fast enough if they want to, most of the swifts live nearer the ground. Some choose fallen tree trunks or old logs for their headquarters; others live in the deserts, where they lie and bask on the burning rocks or play hide-and-seek in and out of the crevices. They are small lizards, though some have such very long tails that they appear to be bigger than they really are. Few when full-grown measure more than ten inches from nose to tail tip, while the tiny swifts that swarm in many parts of the Colorado Desert are only

Here is the true chameleon, a native of the Old World. We cannot tell you what his color is, for it is always changing to match his background. Notice how neatly he has disposed of his long tail, which he can also coil around a branch if it is convenient for him to do so. Notice, too, his strange feet, with the toes gathered together into bundles, and his still stranger eyes, covered with skin except for one little hole. Ladies used to wear these little creatures chained to a pin or a button on their dresses—and very unhappy the poor lizards must have been.

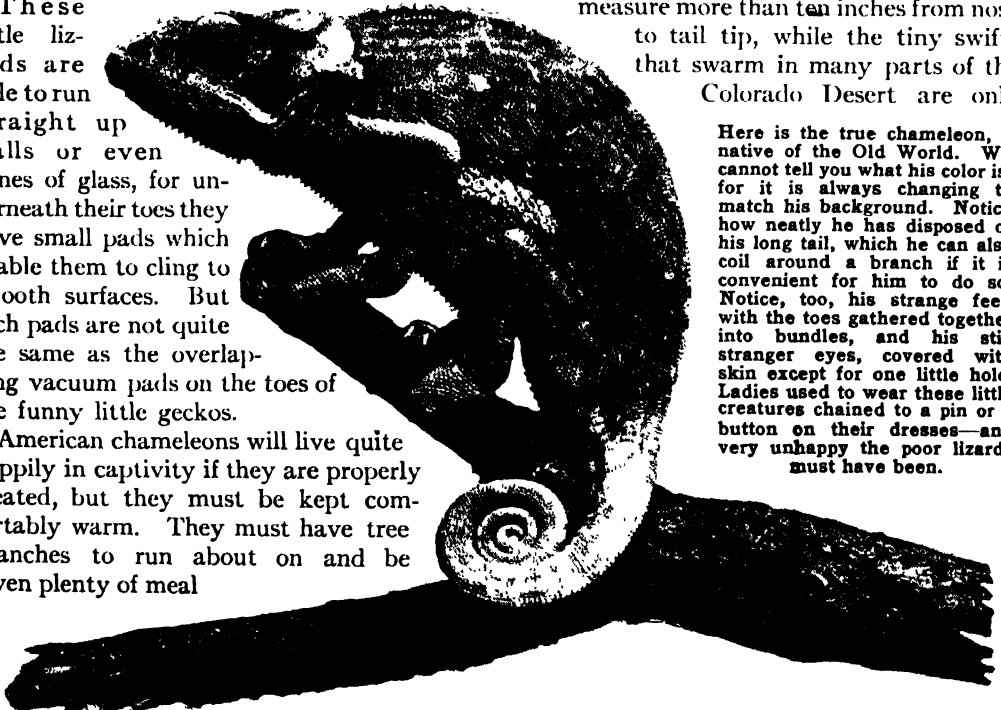


Photo by N. Y. Zoological Society

## STRANGE LIZARDS OF MANY LANDS

about five inches long. Their usual color is dull gray, green, or brown marked with dark spots or blotches, and they match the tones of the rocks so perfectly that one scarcely notices them so long as they keep quite still. But the moment they

All round their plump bodies and queer little wedge-shaped tails is a fringe of spines, and spines of different sizes are dotted all over them elsewhere. On the back of the head and over each eye are several very large spines which stand out like horns and make the odd little lizards look just as if they were decked out in a headdress such as some Indian tribes wear when they are performing their weird dances.

The horned lizards are harmless little creatures. Numbers of them live in the Colorado Desert and in other dry, sandy places. All through the hottest hours of the day they scuttle about under the burning rays of the sun like a lot of queer little goblins, as they hunt for insect prey.

But as soon as the air begins to cool, the lizards shuffle themselves into the sand; and there they

see you, away they dart. A number of little dark streaks whisk away in all directions, and the next instant the lizards are all out of sight!

Quite as small

is the common swift of the Southern United States, which is often to be seen scampering along on the tops of old fences or dodging about among tree trunks in the dry pine lands. This reptile is one of the "spiny swifts," who have very rough coats and are sometimes quite prickly to handle. The largest of the spiny swifts lives in the rocky districts of Arizona and New Mexico. It is a fine greenish-gray lizard, with a broad black and yellow collar; and it is so bristling with sharply pointed scales that it is often called the "porcupine lizard."

### When a Toad Is Not a Toad

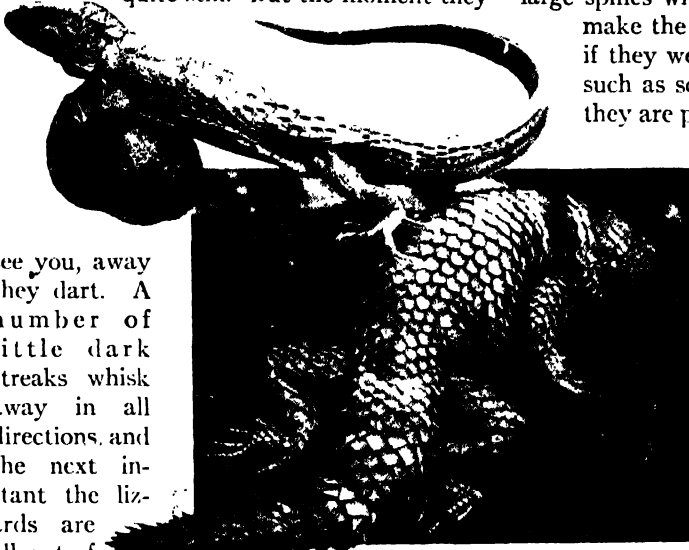
In the United States, as well as in Mexico, we find those strange reptiles called "horned toads"—though they are not toads at all, but a very strange kind of lizard. Instead of being long and slim, like most of the lizards, these funny little creatures are so broad and flat that they really do look more like big toads than anything else.

The little fellow who seems to be playing football is an alligator tiger lizard. In the square is an American swift, and below him a Texas swift. These are all small lizards; and as you may guess from their name, the swifts can move with amazing speed.

stay completely buried until the sun is high in the sky again.

Such an array of horns and spines is a splendid protection to the odd little creatures, but if anyone attempts to harm them they have yet another and very curious way of defending themselves. When frightened or angry, they puff themselves out—like the boastful frog of the old fable—and with startling suddenness squirt a fine jet of blood from the corner of one eye right into the face of the enemy.

Perhaps it is on account of this astonishing trick that many people think that the horned



Photos by N. Y. Zoological Society and American Museum of Natural History



## STRANGE LIZARDS OF MANY LANDS

lizards are poisonous, but they are quite mistaken. There are only two lizards that are really poisonous; one is the "Gila (hē'lá) monster" of Arizona and New Mexico and the other is the beaded lizard that lives in Mexico and Central America.

### The Wicked Gila Monster

These two reptiles are very much alike. They are ugly, wicked-looking creatures with long curved poison fangs in the lower jaw. They grow to be about half a yard long, and have stout, bolster-shaped bodies and short fat tails cov-

ered with small beady knobs of brilliant color. They look as if they were dressed in suits of Indian beadwork.

The Gila monster is bright pink or orange marked with a bold pattern in black, and the creature actually looks poisonous. If it is annoyed the "monster" rears up its head, hisses angrily, and shoots out a forked purple tongue from its mouth. Then if its enemy does not beat a hasty retreat, the lizard seizes him with a sudden dart and a quick snap, and hangs on with its terrible fangs like a bulldog. The Gila monster's bite is deadly to all small animals, and has been known to kill a man. So it is just as well to give this lizard and its beaded cousin a wide berth. It is a heavy, sleepy creature, and seldom leaves its lurking place among the stones and prickly cactus plants in the desert until after the sun goes down. Then it crawls about, dragging its bulky body lazily over the ground as it hunts for its supper. It eats insects or any small creatures

it can snap up. And although it looks as if it would never be spry enough to catch anything that can run quickly, the cunning lizard can move fast enough if it wants to.

The beaded lizard of Mexico is about the same size as the Gila monster, but its coat is black and pale yellow and its tail not quite so short. Its ways are every bit as bad.

Some of the snakelike lizards are often, though quite wrongly, accused of being venomous. These curious reptiles are harmless enough, but they look so much like snakes that many people are afraid of them. You don't see them very often, for they live almost entirely underground, burrowing their way through the soil, just as worms do; and they can move



Photo by N. Y. Zoological Society

These two warty little creatures are the horned lizards, or "horned toads," of the southwestern United States. In addition to their spines they wear coats exactly matching the soil on which they live; and they can protect themselves further by squirting a jet of blood out of their eyes at an enemy. They are harmless and very useful, for they live on undesirable insects.

just as easily backward as forward, whichever may happen to be most convenient.

These strange lizards are both blind and deaf; their eyes are covered with a skin that makes them useless and they have no ears at all. Most of them have no legs; the one called the "two-handed snake" has two funny little limbs just behind its head, but they are really of no use to it.

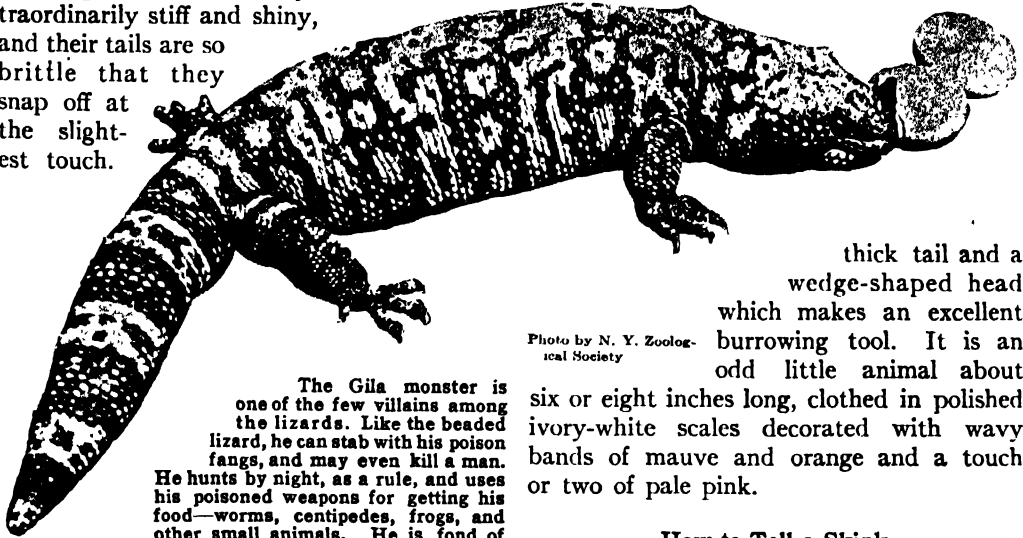
### Lizards without Legs

There are several other legless lizards, also called "snakes" or "worms," which have the same kind of snaky bodies, but are neither blind nor deaf. In America they are often



## STRANGE LIZARDS OF MANY LANDS

called "glass snakes," as they are extraordinarily stiff and shiny, and their tails are so brittle that they snap off at the slightest touch.



The Gila monster is one of the few villains among the lizards. Like the beaded lizard, he can stab with his poison fangs, and may even kill a man. He hunts by night, as a rule, and uses his poisoned weapons for getting his food—worms, centipedes, frogs, and other small animals. He is fond of eggs, too. His coloring is dazzling, a bright pink and orange with strong black markings.

Photo by N. Y. Zoological Society

thick tail and a wedge-shaped head which makes an excellent burrowing tool. It is an odd little animal about

six or eight inches long, clothed in polished ivory-white scales decorated with wavy bands of mauve and orange and a touch or two of pale pink.

### How to Tell a Skink

The European members of this strange lizard family are called "slowworms" or "blindworms." Both names are absurd, as the creatures are not blind and slow nor are they worms. Some slowworms are quite pretty little things, with true lizard-shaped heads, bright shining eyes, and polished coats which gleam with tints of green and bronze. They are often found curled up under stones, but on hot days are fond of basking openly in the sun. Or they will lie with their sharp little heads just peeping out of their burrows in the ground watching for insects or slugs to pass by.

### The Queer-looking Skinks

The skinks are another strange family of lizards that usually live in burrows in the ground or make their homes in hollow trees. Some skinks have long snaky bodies and no legs at all; others have four such tiny legs that they are of no use for walking, but are folded against the sides of the lizard's body as it wriggles its way over the ground. Some skinks have a funny little pair of hind legs only; but most members of the family have four sturdy limbs and well-shaped lizardlike bodies.

The common skink of Northern Africa is somewhat round and plump, with a short,

Like most lizards the little skink loves to bask and play in the sunshine and may often be seen rolling about on the sand in its desert home, playing and gamboling like a tiny porpoise.

The five-lined skink is a native of North America, where it is usually found in the pine woods of the more southern states. The young skinks are gorgeous little things. Their jet-black bodies are marked with fine bright yellow stripes, while their tails are bright blue. As they grow, the young male skinks gradually lose their yellow stripes and become a dark brownish color, while their heads take on a fiery red hue which gives them a very odd look. Lady skinks keep their stripes, and their heads are not quite such a blazing color.

These red-headed skinks are often called "scorpions," though the true scorpion is a totally different creature. Many people are afraid of the harmless skink, for when you see a fiery head suddenly pop out of a hole in a pine tree, it really is a bit alarming.

### The Fabled Two-headed Lizard

There are most interesting skinks both in the New and the Old World. The largest is the giant skink of the East Indies, a fine fellow with a satiny gray coat. It grows to a length of two feet. But the strangest skink

## STRANGE LIZARDS OF MANY LANDS

of all is the queer little "stump-tail" of Australia. This lizard is about eight or nine inches long, and its head and its round knob of a tail are so much the same size and shape that when the comic little animal is dozing with its eyes closed in the sun, one can hardly tell which end is which! Travelers in olden days believed that the little skink actually had two heads and called

tiles, to be found only in the warmer regions of Africa, Asia, and Australia. They have flattish bodies, rather small heads, and long necks. Their tongues are forked like a snake's, and the lizards keep darting them in and out of their mouths and touching everything they can reach with them. As a rule monitors are dull-looking creatures, clothed in black or brown or yellowish green with a few patches of lighter green or yellow here and there. The lace lizard of Australia is, however, an exception, for it is marked all over with a lacelike pattern, and its throat gleams with shining colors of yellow and blue. All monitors eat other

animals. They kill birds and small beasts, first seizing their prey in their jaws and shaking it as a terrier shakes a rat. They eat frogs and snakes and any eggs they can find,

These are all skinks. In the oval is a variety known as Cunningham's skink. Below him is the desert skink. And at the bottom is the friendly little stump-tailed skink, which wears a tail so much like its head that it is hard to say whether the little fellow is going or coming. It makes a funny and good-natured household pet. A skink common in Northern Africa used to be regarded as a powerful medicine for all sorts of diseases, and even yet the Arabs value it both for medicine and for food. Its flesh is said to be very toothsome.

it the "two-headed lizard."

Stump-tails are good-tempered little creatures. They love to lie basking in the hot sun, where their funny tails often swell to twice their usual size. When the nights grow cold and winter approaches, the stump-tail retires to the shelter of an old hollow tree stump or creeps into a hole in a rock. It is seen no more until the warm days return.

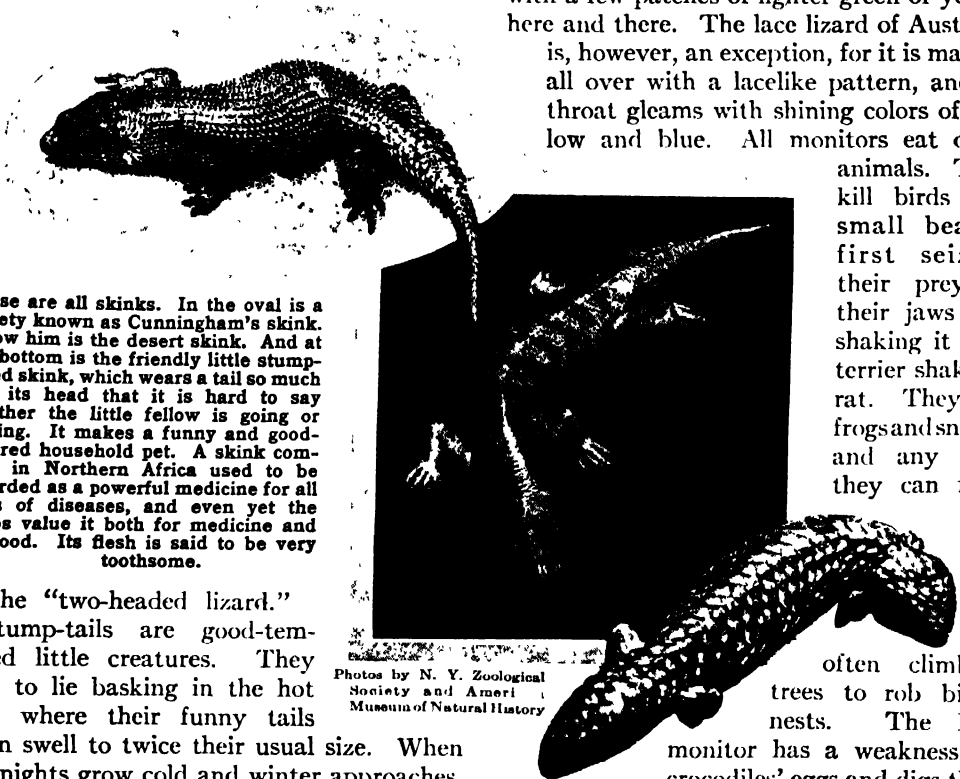
Largest of all the lizards are the monitors. They are the giants of the tribe. Many monitors grow very large and are most awe-inspiring creatures, though if you do not interfere with them they are seldom dangerous. But monitors are usually rather bad-tempered, and if you venture too near one you will probably get a stunning blow from its long tough tail, which can sting like a whip and can knock a man down.

These gigantic lizards are Old World rep-

often climbing trees to rob birds' nests. The Nile monitor has a weakness for crocodiles' eggs and digs them out of the ground whenever it finds a nest. It will eat the young crocodiles, too, soon after they are hatched; so the Nile monitor is often very useful in helping to keep down the crocodile population.

### The Giant Water Monitor

The great "water monitor" grows seven or eight feet long and is equally at home on land and in the water. This big fellow lives in Southern Asia and Australia, where it frequents the jungles and marshy districts. It can climb up on the branches of low trees; tear through the scrub at a surprising rate, making a tremendous noise as it goes; and



Photos by N. Y. Zoological Society and American Museum of Natural History

## STRANGE LIZARDS OF MANY LANDS



Photo by American Museum of Natural History

Here is a typical scene on the edge of a desert. The deadly cobra, at the left, has reared itself up ready swim easily in the streams and rivers, keeping its feet close against its sides and swishing its tail from side to side as a crocodile does.

### The Largest Lizard in the World

For a long time the great water monitor was believed to be the largest of all living lizards; but a few years ago a still larger monitor was discovered on the small, almost unknown island of Komodo, in the Malay Archipelago. The natives of Dutch East India had long declared that terrible creatures twenty feet long, of ferocious habits, prowled about in the dense forests of the island, but no one really believed the tale until in 1927 two young monitors of an unknown species were captured and brought to Europe. These "Komodo dragons," as they are called, were already nearly seven feet long, and no one as yet knows how big they will be when they are grown up. The two "dragons," named "Sumba" and "Sumbawa," now live in the London Zoölogical Gardens, where they are quite happy and have grown so tame that the keepers often take them for a walk around the grounds before the visitors arrive. They will take food from the keeper's hand and are very fond of eggs, which they bolt whole without breaking the shells.

Before we say good-bye to the lizards, we must not forget to make the acquaintance of

to strike at a water monitor. Monitors enjoy a juicy snake for a meal, and are very fond of snakes' eggs.

the Old World chameleon, which in many ways is so unlike the rest of the tribe that some people think it should not be called a lizard at all.

Except that it has the same trick of changing color, the true chameleon is not in the least like the lively American lizards of the same name. It is as slow as they are quick. It climbs wearily over the branches of the trees or bushes on which it lives, stopping every now and then with one foot in the air as if it were too tired to go any farther. It can change its shape, too, as well as its color. Sometimes as it moves wearily over the trees the queer little animal is quite long in the body, and so woefully thin that its two sides seem almost to touch. But try to stop its slow promenade, and the creature arches its back and puffs itself out like an inflated paper bag. At the same moment its throat pouch swells out, its mouth gapes wide, and the chameleon hisses, rolls its eyes, and jerks its head from side to side in a towering passion. It looks for all the world like an angry hobgoblin!

### This Lizard Looks Two Ways at Once

On its head the chameleon wears a kind of helmet. Its bulging eyes are as round as marbles and covered with a crinkly skin, through which you can see a tiny spot of light. These strange eyes can be moved independently, so the chameleon can look two

## STRANGE LIZARDS OF MANY LANDS

ways at once. While one eye is pointing to the sky the other may be turned down to examine the ground below; or one eye may be looking forward and the other backward. And they are never still. The animal is always rolling them round and round and squinting in all directions! As for the

easy to determine, for it is constantly changing to suit the occasion. When surrounded by green leaves the little reptile is usually green to match them. It may be light green or dark green, gray-brown, yellow, or black. Sometimes it is the same hue all over, and sometimes it is spotted and striped with



Photo by American Museum of Natural History

Here is a trio of "Komodo dragons," which are a kind of monitor and the largest of all lizards. They may

attain a length of as much as twenty feet, and are all that are left to remind us of the great lizards of old.

chameleon's tongue, it has a sticky spoon-shaped tip and can be stretched out ever so far like a piece of elastic. If a fly alights on a leaf five or six inches away, the tongue shoots out in a flash. And then? Why, the fly has disappeared; and the chameleon is chumping its jaws and rolling its eyes in joy!

### A Magician among the Lizards

Even the feet and the tail of this queer little reptile are peculiar. Its toes are bound together in two little bundles, so the chameleon climbs about and grasps the twigs and slender branches of the trees in much the same way as a parrot does. Its tail, instead of being stiff and straight like a lizard's, can be coiled up in a spiral, or twisted round a branch like the tail of a South American monkey.

The exact color of the chameleon is not

contrasting colors—such as white or yellow on a dark green ground, pink or pale green on cream color, or black on dull gray. These changes of color occur when the chameleon is angry or excited in any way; or they may be brought about by changes in light or temperature or in the general coloring of the little creature's surroundings.

The common chameleon of North Africa is about five or six inches long. The dwarf chameleon of South Africa is a tiny little creature hardly two and a half inches in length, while the great chameleon that lives in Madagascar is the giant of its kind and sometimes measures as much as half a yard.

There is still one more strange, lizardlike creature that we must not forget to notice, and this is the tuatara (*tōō'ā-tā'rā*). It is not really a lizard—but then, it does not belong to any of the existing tribes of reptiles, and we must put the poor thing somewhere.

## STRANGE LIZARDS OF MANY LANDS

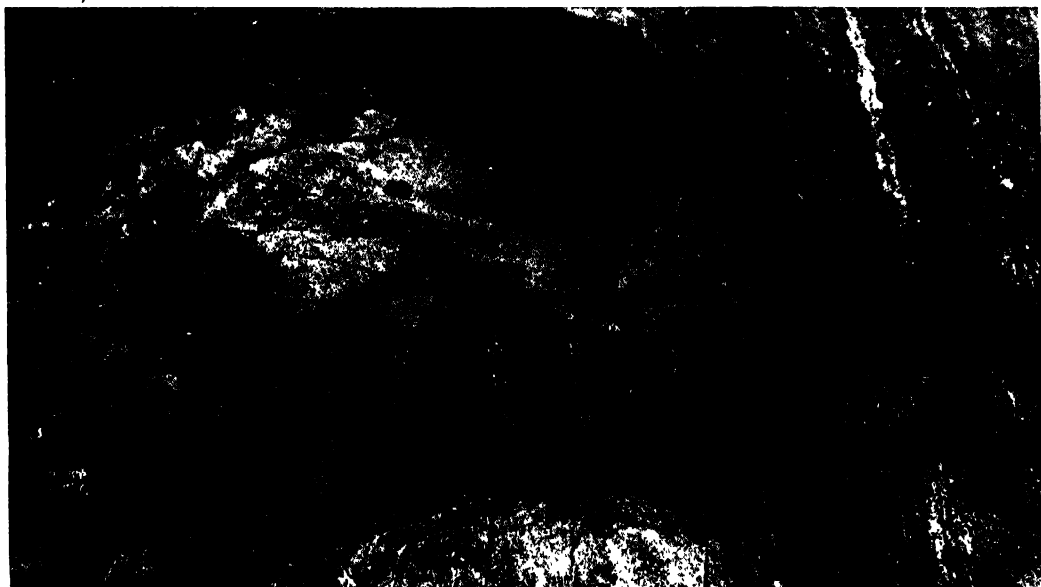


Photo by Zairi'au Museum of Natural History

This Ceylonese monitor looks like some strange but beautiful bead bag that might have come into fashion. Though he is not large himself he has some mammoth

relatives. Most monitors are very sober in coloring when they are fully grown and—as you see—sink into their background. When young they are spotted.

The tuatara is actually the last surviving member of a race of reptiles that lived on the earth in prehistoric times. It lives now only on a few small islands belonging to New Zealand; and even there it will probably not be seen much longer, for it is growing very rare, and in a few years may be as extinct as the dodo.

This old-time reptile is a harmless creature. It grows to about two and a half feet long, and looks like a stout lizard with a big head—somewhat like an iguana. In the daytime the tuatara is seldom to be seen. It lives in a burrow in the sand and goes abroad only at night. Two tuataras have never been

found living together, yet, strange to say, these reptiles will often allow a petrel to share their homes and even to make its nest there. The two odd companions live together in a perfectly friendly fashion. Some people say the bird actually helps to dig the burrow, but it is usually the reptile who does most of the work. Anyhow, this odd couple do not appear to quarrel with each other, though each of them is careful to keep to his own side of the apartment.

The tuatara is so rare and so interesting to scientists that it is protected by law, and the killing or capturing of specimens is forbidden.



Photo by N. Y. Zoological Society

The piebald chuckawalla goes right through life wearing a suit several sizes too large for him.

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# REPTILES

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## Reading Unit

### No. 5

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## THE SLOW-GOING TORTOISE AND THE SLEEPY TURTLE

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

### *Interesting Facts Explained*

What the shell of a turtle or tortoise really is, 3-466-67  
What tortoises and turtles eat, 3-466  
Where tortoises and turtles live, 3 466-67  
How long tortoises can live with-

out food, 3-467  
A tortoise's length of life, 3-467-68  
The largest tortoises in the world, 3-468  
Different kinds of tortoises, 3-469

### *Things to Think About*

Why is it easy to recognize a tortoise or a turtle?  
To what use do tortoises put their shells?  
How many teeth does a tortoise or a turtle have?

How would you feed a tortoise or a turtle in captivity?  
How are sea turtles fitted for ocean life?  
How did tortoises get water on desert islands?

### *Picture Hunt*

Where do giant tortoises live today? 3-465  
How does the box tortoise completely hide itself? 3-466

What kind of tortoise lived millions of years ago? 3-467  
How did the gopher tortoise get its name? 3-468

### *Related Material*

What has happened to the legs of sea-going turtles? 3-478

How heavy is the largest turtle in the world? 3-480

### *Leisure-time Activities*

PROJECT NO. 1: If you can find a box tortoise, learn how it uses its hinged lower shell. Feed it some lettuce and banana. Release it where you found it, as

soon as possible, 3-466  
PROJECT NO. 2: Visit your local museum or zoölogical park and study the tortoises and turtles there.

### *Summary Statement*

Tortoises and turtles have shells which protect the upper and lower parts of their bodies. These animals have beaks, but

no teeth. Sea turtles have flippers instead of legs. All turtles and tortoises lay eggs on dry land, never in water.

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## THE TORTOISE AND THE TURTLE

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It is no steed out of fairy-land that this boy is riding at the zoo. It is a real turtle, or rather a tortoise—one of the giant race that live on the Galapagos Islands far out in the Pacific. We could imagine it to be the very tortoise that Aesop told about the one that beat the swift hare in a race because, slow as it was, it just kept plugging away!

New York Zoological Society  
Photo



### *The SLOW-GOING TORTOISE and the SLEEPY TURTLE*

*They Carry Their Houses with Them, but They Do  
Not Stay at Home on That Account*

**I**F EVERY creature had a motto, the tortoise might be given "Slow and sure." Slow he certainly is. But with such a heavy shell to carry on his back, he can hardly be expected to dash about like a lively lizard.

To judge from his dogged behavior, the tortoise is "sure" too. There was once a little girl who kept one of these slow and sure gentlemen as a pet, and all through the summer she allowed him to roam about the garden as he pleased. Now "Jimmy," as he was called, had a great weakness for pansies, and was usually to be found sitting in the middle of the pansy bed, munching up the flowers as fast as ever he could. Over and over again the little girl would pick him up and carry him away to the other end of the garden. There she would put him down on the grass near a nice clump of dandelions, or try to distract his attention with a few fresh lettuce leaves. But it was of no use.

Jimmy just sniffed at the dandelions, stamped on the lettuce, turned himself slowly round and marched steadily down the garden path straight back to the pansy bed. He was sure enough of what he wanted.

You could never mistake a tortoise or a terrapin—which is only a particular kind of tortoise—for any other animal. No other four-legged creature has "a home of its own" which it carries about wherever it goes, and into which it can retire, like a snail, whenever it feels so inclined. As old Uncle Remus says, "Rain er shine, hot er cole, strike up with ole Bre'r Tarrypin w'en you will en w'ilst you may, en whar you fine 'im, dar you'll fine his shanty."

But to call the shell of a tortoise a house or a "shanty" is not altogether correct. To be sure it serves as a shelter to protect its owner from violent storms of rain, or as a fortress within which he can defy all but the strongest and most cunning of his enemies;

## THE TORTOISE AND THE TURTLE

but the shell is more than this. It is simply a part of the tortoise, and he could not possibly come out of it, even if he wanted to. The large upper shell, called the carapace (kār'ā-pās), might be compared to a low gabled roof on a house. The backbone of the animal would then correspond to the ridgepole, the ribs would be rafters, and the hard flat bony plates which are welded together to form the shell would be the shingles on the roof. In the case of fresh-water soft-shell turtles the roof might be said to be covered with tar paper or tin, for the bony plates of the shell are replaced by a tough skin that is stretched across the spine and ribs.

All those bony plates that are so firmly welded together make a dome-shaped covering of great strength to protect the soft body of the tortoise; and each plate is covered with a shield of horn which gives the shell its coloring. The lower portion is made up in the same way from the breastbone and is called the "plastron" (plās'trōn). In the true land tortoises the two halves of the shell are joined together to make a strong box with an opening at each end, one for the head and forelegs and the other for the tail and hind legs to come through when the animal wishes to take a walk. Its head and legs are protected by horny scales and its toes are provided with strong clawlike nails; so the tortoise has little to fear from the claws and teeth of other creatures.

### The Toothless Tortoise

It has no teeth of its own, but its strong horny beak has sharp cutting edges and is able to bite up food easily enough. A tortoise makes a tremendous business of eating, however, and it is really a funny sight to see a sedate old fellow tearing little bits from a cabbage leaf while he holds it firmly down

with his foot. He jerks his head up and down, as he rolls the morsels round in his mouth, and then swallows them with great gulps, as if he were in danger of choking.

### The Most Intelligent Reptile

Although they seem so slow and sleepy, tortoises are not at all stupid. They are

The box tortoise has a hinge on the lower part of his house, as shown at the left, so that he can shut the door securely against all his enemies. When he comes out of his shell he is an amusing enough creature, as we can see from the picture below.

the most intelligent of all reptiles. They soon grow tame and will take food from your hand if you offer them something they like, such as a nice juicy lettuce leaf. They feed on plants, and do not eat slugs and insects, as people often think they do. At least most land tortoises do not; terrapins and fresh-water turtles will eat all sorts of things—insects and snails, tadpoles and frogs, small



by N. Y. Zoological S.

fishes and young crawfish, as well as berries, fruit, and vegetables of all kinds. Tortoises, terrapins, and fresh-water turtles are all much alike but they have their own particular tastes and habits. True tortoises live always on dry land, and some even make their homes in hot, sandy deserts, sleeping by day in burrows in the ground and coming out at night to prowl around and munch the prickly cactus plants and the scanty tufts of dry grass that grow in these desolate places. They have queer club-shaped feet—rather like elephants' feet—and strong claws for digging out their burrows in the ground.

Fresh-water turtles and terrapins spend a good deal of time in the water or in marshy places, and though most of them are equally at home on land, they are never found in the dry, waterless parts of the world. They mostly have webs between their hind toes to help them to swim.



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## THE TORTOISE AND THE TURTLE

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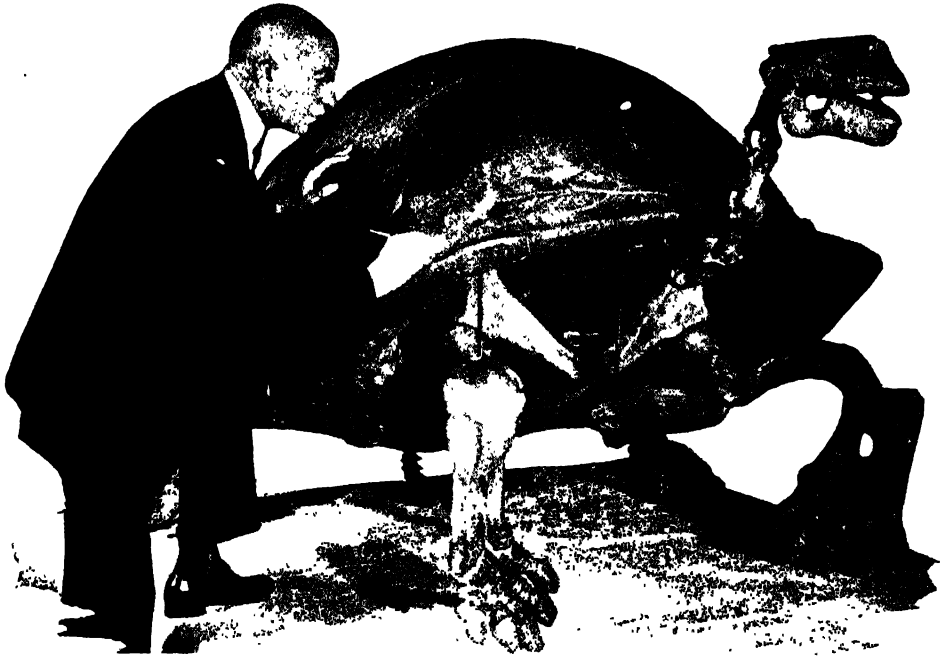


photo by American Museum of Natural History

The tortoises we call "giant" would look pretty small beside this monster, who was waddling about Northern India long ages ago. There his shell was dug up in 1923, broken into thousands of little pieces; it took the scientist who put them together two whole years to

solve the puzzle. And now here the old giant stands—seven times as big as any living tortoise in the New York zoo. His shell measures more than seven feet over the hump from front to back; he is the largest land tortoise ever discovered.

The sea turtles are different in many ways from most of the tortoise tribe. They have long flippers instead of walking legs, and live in the sea, often swimming quite far away from the land and only coming on shore occasionally to lay their eggs or bask for a while in the sun.

### When Turtles Go on the Warpath

Land turtles are usually good-tempered. They spend their time in sleeping and eating and sleeping again, and seldom interfere with their neighbors. All they ask is to be allowed to go their own slow way in peace; though when they are roused to wrath, two rival males occasionally have a real stand-up fight. They clash their hard shells together and do their best to bite each other in the neck or the upper part of the leg where the soft skin is unprotected by horny scales. But although they make a great fuss and commotion about it, the combatants seldom damage each other seriously, and after the

battle is over they turn about and make off in opposite directions or retire into their shells for a nap.

### Six Months without Food

Not content with sleeping away a large part of the day and night, most tortoises take a complete "rest cure" once a year. In tropical countries they retire from the world and slumber through the hottest, driest months; but in more temperate parts of the world they burrow into the ground as soon as the days begin to grow cool and stay there until the return of the spring. Some tortoises pass five or six months of the year in this way, in a torpid condition called "hibernation" (hī'bēr-nā'shūn); and during all that time they have nothing to eat.

### The Great Age of the Tortoise

Tortoises often live to a very great age, as is only natural in creatures that sleep so much and take life so easily. One old fellow

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## THE TORTOISE AND THE TURTLE

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Photo by American Mus.

These burrows were not made by prairie dogs, but—surprisingly—by tortoises. We call this funny, flat species of tortoise, which digs down into warm Florida sand, the gopher tortoise because its house is so like the house of a gopher. The artist has shown us one

burrow with the side cut away, so that we can see a tortoise going down into its home, probably to take one of the good long naps of which these creatures are so fond. There is also a heap of eggs buried by the mother tortoise just outside her front door.

lived in a zoological garden for over 130 years; and since he was full-grown when he was captured, he must have been several years older than that when he went to sleep for the last time. Another big tortoise was believed to have lived at least four hundred years, and this is quite possible.

### The Biggest Tortoise in the World

The biggest tortoises in the world to-day are the "giant" and "elephant" tortoises that live in a few small tropical islands in the Pacific and Indian oceans. Some of the monsters have shells fully four feet long and weigh well over four hundred pounds. They are now growing very rare, for they have been carried off in hundreds from their island homes, and their eggs have been collected, too. So only a few are now left where thousands used to live before men started interfering with them. In the old days large flocks of giant tortoises roamed about and fed and dozed in the burning heat of the Galapagos Islands, which form

a tiny archipelago about five hundred miles west of the South American coast. So close together did the sleepy creatures lie that you might walk for a hundred yards or so by stepping from the back of one tortoise to another!

On some of the islands, where there was no water at all, the giants munched the thick juicy leaves of the cactus plants that grew all about—so they satisfied their hunger and quenched their thirst both at the same time. But on the larger islands, where there were plenty of springs and pools, the tortoises were very fond of drinking and wallowing in the mud. They sometimes traveled long distances for a good drink of water, plodding steadily along for miles, spending several days and nights on the march, and moving at the rate of a yard a minute! But they did not mind how long they were on the way if only they could get what they wanted in the end. The tortoises have always been "slow and sure."

Beside these huge creatures, ordinary tortoises seem pigmies, though some other

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## THE TORTOISE AND THE TURTLE

species are of a very fair size. The North American gopher tortoises are often as much as twelve inches long, though their flat shells keep them from looking so imposing as some of the land tortoises that stalk about under portable houses as high and as rounded as dish covers.

These tortoises live in the dry, sandy wastes of the southern states. They are not very often to be seen, for they pass most of the day reposing in their burrows. These are nearly two yards long and slope gradually downward to a depth of four feet. The gophers dig out their long narrow tunnels with their strong forefeet, which are flattened and protected with horny shields that make capital spades for digging in the sand. A mound of sand before the doorway marks the entrance to one of these underground dwellings; so it is quite easy to discover where the gophers lie hidden.

These tortoises spend the hot hours of the day as well as the night quietly at home at the deep end of their burrows. At dawn, when the dew is on the grass, they come up to the surface and prowl about, munching anything green they can find, or any crops of fruit and berries that may grow in such desolate places. They will also eat the gum that oozes from the pine trees. By eight or nine o'clock in the morning they will all be back in bed; and unless they are tempted to come forth after a nice shower of rain, to see if any fresh green shoots have sprung up, they are seldom seen again until the early hours of the following day.

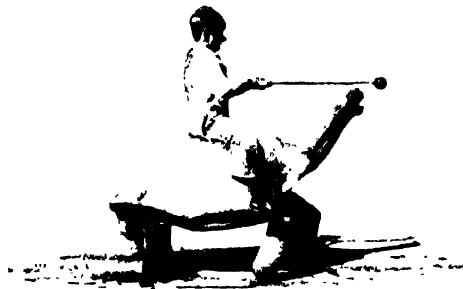
A pair of these tortoises usually live peacefully together in each burrow, but they never have the children with them. The

mother buries her large round eggs in the ground outside the door of her house, and the young tortoises have to find their own food and dig out new tunnels as homes for themselves.

The gophers are not very handsome. In fact they are often called "dingy gophers" because their shells are a dull, dark brownish color, with no ornamentation. As the animals grow old, the raised pattern on their back shields is quite worn down and the shell grows perfectly smooth.

The Brazilian tortoise is a much finer creature. It grows fully half a yard long. The shields on its carapace are black, with a bright yellow spot in the center, while the scales on its head and forelegs are tinged with bright red or orange colors.

This tortoise lives in the wooded districts of tropical South America. In spite of its strong bony fortress it often falls a victim to the fierce jaguars and the pumas, who rip off its shell with their powerful claws. It is hunted, too, by the Portuguese and the native Indians, who fatten it for the table. So altogether this fine tortoise has rather a bad time of it. In the hottest part of the year it takes a long rest under a heap of dried leaves, and the mother makes a rough nest of leaves and litter and buries her eggs underneath. The baby tortoises have soft shells at first and are a yellowish-brown color without any spots. They wander about where they will and feed on green leaves, grasses, and the fruit that falls from the trees. But many of them get eaten up themselves before they are very old, for most of the wild jungle folk are very fond of tender young tortoises.



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# REPTILES

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## Reading Unit No. 6

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### FRIENDLY TORTOISE AND SURLY SNAPPER

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How tortoises spend the winter months, 3-472  
The habits of the box tortoises, 3-472  
The habits of terrapins, 3-473-75  
Laws that protect turtles, 3-475  
The fierce snapping turtles, 3-475-77

Why sea turtles come ashore, 3-478  
The dangers that face baby sea turtles, 3-478  
A turtle weighing half a ton, 3-479-80

#### *Things to Think About*

What are the weak spots in a tortoise?  
Where do terrapins go during the cold winter months?  
What makes the snapping turtle fearless in spite of its poor shell?  
What turtle uses its tongue as a

bait for fishes?  
Why do not sea turtles increase in number since each female can lay more than a hundred eggs?  
What modern turtle is over six feet long and weighs half a ton?

#### *Picture Hunt*

What fate lies in store for most baby snapping turtles? 3-473  
What is interesting about the turtles of the Galapagos Islands? 3-474  
What means of protection have snapping turtles? 3-476

Why is it dangerous to molest an alligator terrapin? 3-477  
From what turtle is turtle soup made? 3-478  
Which turtle on this page swims in the ocean? 3-479

#### *Leisure-time Activities*

PROJECT NO. 1: The next time you find a dead tortoise, prepare the skeleton as follows: Saw apart the upper and lower shells. Boil the reptile in a weak solution of lye—lye is dangerous to the skin—until the meat can be lifted

from the bones. Wash the shells and let them bleach in the sunlight.

PROJECT NO. 2: Visit an aquarium to see live sea turtles and their shells.

#### *Summary Statement*

Snapping turtles destroy birds and large numbers of useful fish.

Most turtles and tortoises are harmless and may be kept as pets.

## FRIENDLY TORTOISE AND SURLY SNAPPER

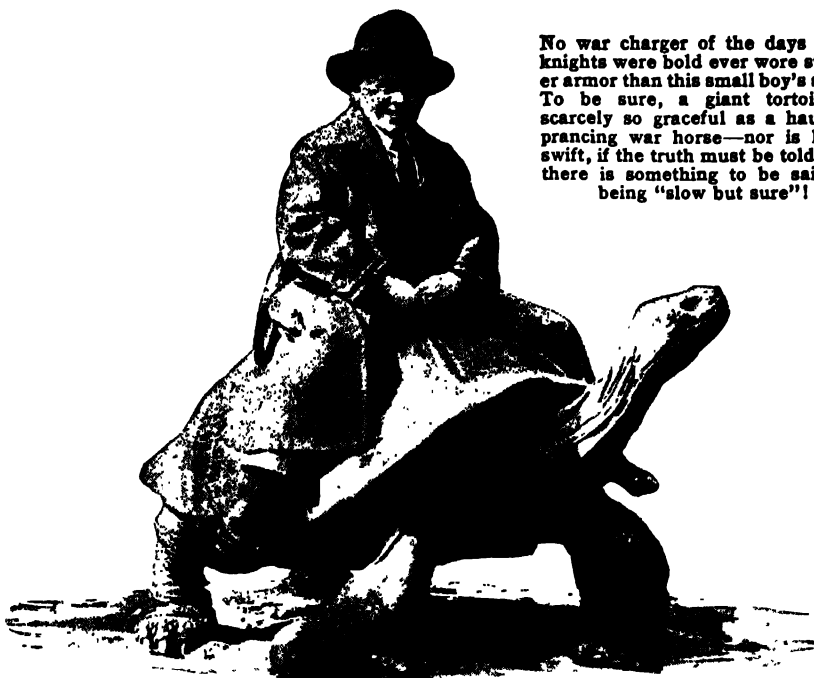


Photo by N. Y. Zoological Society

No war charger of the days when knights were bold ever wore sturdier armor than this small boy's steed. To be sure, a giant tortoise is scarcely so graceful as a haughty, prancing war horse—nor is he so swift, if the truth must be told. But there is something to be said for being "slow but sure"!

## FRIENDLY TORTOISE *and* SURLY SNAPPER

*The Tortoises and Turtles May Give Their Shells to Use for Ornament and Their Flesh to Be Made into Soup, but Certain of the Tribe Should Always Be Regarded with Suspicion*

**T**HEIR pretty shells and sturdy, stubborn ways make certain land tortoises amusing pets. There are many more of them in the Old World than in the New. All over Southern Europe and Asia and the whole of Africa several different kinds of these slow-going reptiles are to be found leading what looks like a very dull and uninteresting life. The common European tortoises are rather small, with high, rounded shells which are often handsomely ornamented with dark brown spots and patches on a yellow ground. It is these little tortoises that are most often kept as pets. They make themselves quite at home in the garden and find their own food without giving any trouble—if their owner does not mind having his favorite flowers eaten now and then, or finding large holes bitten in the pumpkins or gourds. They are very method-

ical in their habits. They go to sleep early and get up late and take several naps in between. They nearly always fix on one particular spot in the garden as their headquarters. It may be under a bush or a clump of flowers or a rubbish heap, or even in a bare corner right up against the wall. Regularly every afternoon you may see the queer creatures stumping off "home" to sleep, long before the sun has set.

Though you would hardly expect it, these tortoises appear to be much attracted by music. At least so we are told by a doctor who kept several Greek tortoises in his garden in Switzerland. Every day, he says, when the band had begun to play outside the house, all the tortoises toddled as fast as their stumpy legs would carry them toward the garden fence. There they would stay with their necks stretched out, slowly

## FRIENDLY TORTOISE AND SURLY SNAPPER



There is never an end to the queer ways Mother Nature's children have of protecting themselves. The box tortoises crawling around among the cactus plants above can draw in their heads and feet and close bony shutters over them to keep out the world. And the hingeback tortoise at the right can let down the hind part of his scalloped carapace on a sort of hinge over his tail.

Photos by N. Y. Zoological Society

shields on its back is marked

with a number of

bright yellow or orange lines in the shape of a star. It

lives among the hills in grassy jungles, where it stays under scrub or tufts of grass during the heat of the day and comes out to feed only in the early morning or late afternoon. But in the rainy season it grows more lively and often wanders about in search of food at all hours of the day.

nodding their heads to the music until the concert was over. Then they immediately turned round and marched back to the other end of the garden. So although we cannot see their ears, since they are under the skin that covers the head, tortoises can evidently hear very well indeed.

In the autumn the tortoises will bury themselves in the garden or rubbish heap, where, if the winter is mild and they dig deep enough, they will be all right until the spring. But it is wiser to put them to bed in a box of hay in a shed or cellar, where they will not be too hot or too cold during their long winter sleep.

### The Starred Tortoise of India

One of the prettiest of the Old World tortoises is the Indian starred tortoise. Its shell is jet black, and each of the separate

### A Clever Way of Hiding Eggs

The mother has an unusual way of making quite sure that no one shall discover the place in which she has hidden her eggs. First she digs a hole in the ground about six inches deep and five inches wide. In this she deposits four large round eggs, and carefully covers them up with the loose earth she has scraped out of the hole, stamping it well down with her stout hind feet. Then stretching her hind legs so as to raise her shell as high above the ground as she pos-

## FRIENDLY TORTOISE AND SURLY SNAPPER

sibly can, she suddenly lets herself drop on the top of the nest. She repeats the trick over and over until she has battered the earth well down and the ground is perfectly smooth and firm. After carefully inspecting the spot to make sure that there is nothing to give her secret away, she takes a little rest after her labors and then stumps away.

### "Bre'r Tortoise Lie Low and Say Nuffin'"

When an ordinary tortoise retires into its strong shell it is fairly safe from its enemies. Prowling creatures may knock on the roof of the house and try to force their way in, but they can't get inside; and "Bre'r Tortoise, he just lie low and say nuffin'," until they grow tired of the game and go off in disgust. But a big, strong beast of prey like a leopard or a jaguar will turn the poor old tortoise over on his back and attack him with its long claws in his weak spots—the openings through which his head and his feet pop in and out.

There are some tortoises, however, that baffle all but the very strongest of the big cats, for they have no weak spot in their armor. You may turn them over and over without finding a hole or a crack anywhere. The shell is closed up all the way round. The hinged tortoise of tropical Africa can close the back entrance to his house but not the front one, while the American box turtles can shut themselves in both behind and before.

### A House of Many Gables

The hinged tortoise is an odd-looking creature. Its shell is all humps and angles. Across the back is a kind of hinge, and the hind portion can be bent right down when the animal is safely inside. The forefeet of

this tortoise are covered with very hard bony scales, and they fit tightly together to make a strong front door.

The box tortoises are hinged across the lower shell, and the two halves close like shutters against the upper one; so the animals can really shut themselves up in a strong box when they wish to retire from the world. The Carolina box tortoise is the best-known of these curious reptiles. It is not very big—about five or six inches long as a rule. Its shell is a very dark brown marked all over with splashes of yellow, which often form a large "E" on both sides.

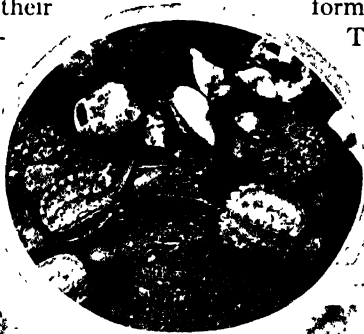
This tortoise lives in dry woods.

It crawls under low bushes, shutting itself up tightly during the heat of the day and not venturing out until the light begins to fail. Late in the evening and even at night it wanders about looking for food. It hunts for earthworms and insects, and eats plenty of berries and tender green shoots as well. It is very fond of blackberries, and in the berry season its front feet and its jaws are stained quite black with the fruit.

Box tortoises are timid little creatures. If anything alarms them, their shutters go

up in an instant, and they will not show themselves again for a long time. They float like buoys if they are thrown into the water, but they do not like it and they scramble back to land as quickly as they can. They can swim very well, however, and will sometimes go into the water of their own accord.

The terrapins (těr'ă-pîn) really love the water. They spend nearly all their time paddling about in the rivers and streams or the still, muddy pools on the marshlands. They float near the surface or swim about after small fishes; they hide under stones or among the water weeds; and some of the



Photos by American Museum of Natural History, and N. Y. Zoological Society

The absurd little creatures in the circle are baby snapping turtles just out of the shell—still much more likely to be snapped at than to snap. Below them are two of the prettily marked yellow-bellied terrapins.

## FRIENDLY TORTOISE AND SURLY SNAPPER

smaller ones, sometimes called pond turtles, like to climb up on old floating logs and

grow to a fair size and have fine shells that may measure twelve



bask all in

a row in the sun.

But startle the terrapins and one after another they tumble off their perch and scuttle in a frantic hurry to the bottom of the stream, where they hide in the mud among the water weeds until all danger is passed. Then one little head after another will pop up again out of the water; and when they have made quite sure that no terrible creature is lying in wait to catch them, all the little terrapins scramble up on their log again.

Young terrapins are often pretty little things. They have green shells marked with yellow or black in all sorts of different patterns, while their breastplates are yellow with brown spots and patches. At first they live chiefly on flies, which they eagerly watch for with their bright little eyes and snap up as the insects dance over the surface of the water. As the terrapins grow bigger they gobble up tadpoles, chase frogs and tiny fishes, and bite off the tender shoots of the water plants. Some terrapins pass the night lying in the mud at the bottom of the water, others creep under masses of moss on the banks of the streams; and when winter comes they dig holes in the banks and bury themselves until the following spring.

Some of the terrapins are quite small, not more than six or seven inches long, but others

Photo by American Museum of Natural History

Except the fierce snappers, turtles are on the whole a peaceable race. Yet here are two spotted turtles fighting away at a great rate.

with finely marked and prettily colored shells. One of the prettiest is the "painted terrapin." It is only about six inches long and has a smooth dark olive-colored shell with a red, black, and yellow border, and each of the back shields is outlined with yellow.

The skin on the neck, legs, and tail of the terrapin is also colored with red and yellow stripes on a black ground. This bright little creature is a native of the Western United States. Another and much bigger terrapin which is called the "cooter" and is found in the southeastern states has an olive-colored shell marked with a striking pattern in yellow, while its head is striped with orange and red.

Although all terrapins have webbed feet and are capital swimmers, a few species often

leave the water and wander quite a long way inland, searching for berries and tender green shoots. The large wood terrapin often spends most of the summer in the woods or marshes and makes regular tracks from one stream to another.

### A Law to Protect the Terrapin

Like many of its relatives, the terrapin is good to eat, and at one time it was collected in such quantities for the markets that it was

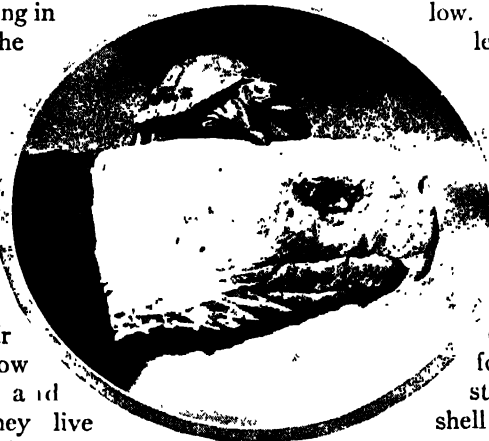


Photo by N. Y. Zoological Society

Not all the tortoises which live in the Galapagos Islands are giants. Here is a member of a pigmy species sitting perkily on the head of one of the big fellows.



## FRIENDLY TORTOISE AND SURLY SNAPPER



The painted terrapins in the upper picture are only five or six inches long, but are gay and attractive in their green-and-yellow jackets. Someone has accommodatingly turned one of them over, so we may see how the pretty markings extend to the under side of the carapace. At the right is a startled-looking wood turtle scuttling out of the picture.

Photos by N. Y. Zoological Society, & American Museum of Natural History

almost killed off. Fortunately a bill was passed in New York State in time to prevent this, and now people are forbidden to collect the wood terrapin and the box turtle.

### Turtles That Live in the Mud

Most terrapins have the upper and lower halves of their shells joined together, but in many fresh-water turtles the breastplate of the animal is connected with the carapace (kār'ā-pās)—or large upper shell—by only a bridge of bone on each side. There are a great many of these strange water reptiles in all parts of America as well as in most of the warmer countries in the Old World. The mud turtles and the musk turtles are fond of muddy lakes and rivers. They are all rather small, with dark-colored shells and heads which look much too big for their size. They have broad webs between their toes and can swim very quickly, but they spend a good deal of their time pottering about in the mud among the weeds at the bottom of the pools, snapping up little fishes, crawling water insects, or tadpoles that wriggle too near.

Mud turtles and musk turtles are harmless

little reptiles. They do not trouble anybody—except fishermen sometimes, when they bite the bait from the hooks. But the snapping turtles are very much disliked, for they are bad-tempered creatures that are always snapping at everyone and everything they see. The common “snapper” is the tyrant of many of the rivers and lakes of Canada, the United States, and Central America. It is a giant among turtles, measuring three feet or more from its nose to the tip of its stout, pointed tail. Its huge head is too big to be drawn all the way back under its shell, which is too small to cover the animal properly; and its breastplate is nothing but a small, cross-shaped bony shield, which gives no protection to the turtle at all.

### Beware of the Snapper!

But this does not signify. The snapper is big enough and strong enough to take care of itself, and is not at all shy or timid. Its jaws are so sharp and powerful that they can snap a man's finger right off or take a large bite out of the leg of a bather. It

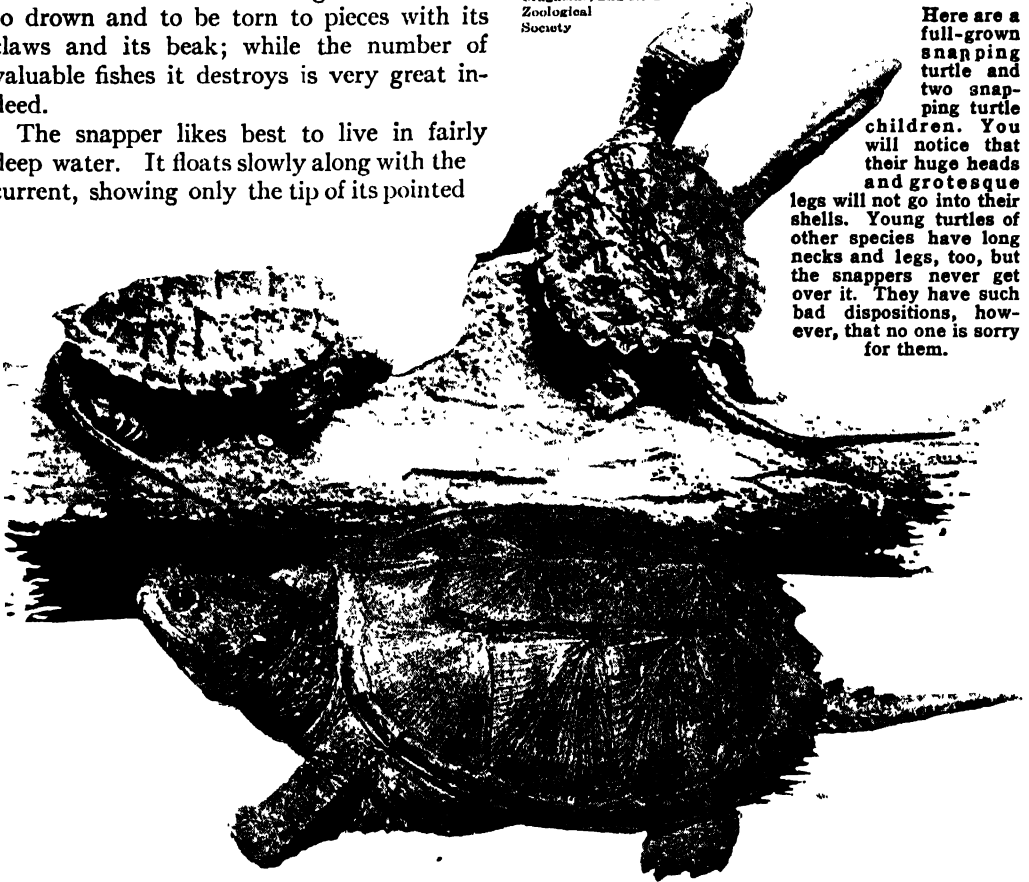
## FRIENDLY TORTOISE AND SURLY SNAPPER

seizes water birds and drags them below to drown and to be torn to pieces with its claws and its beak; while the number of valuable fishes it destroys is very great indeed.

The snapper likes best to live in fairly deep water. It floats slowly along with the current, showing only the tip of its pointed

Photos by Nature Magazine, and N. Y. Zoological Society

Here are a full-grown snapping turtle and two snapping turtle children. You will notice that their huge heads and grotesque legs will not go into their shells. Young turtles of other species have long necks and legs, too, but the snappers never get over it. They have such bad dispositions, however, that no one is sorry for them.



snout above the surface. But its fierce beady eyes are ever on the alert to spy and its jaws ready to snap at passing fishes. At other times the creature will prowls along near the edge of the stream and grab the frogs squatting on the banks. Or it may lie half buried in the mud at the bottom of the water and wait for its dinner to come to it. There is nothing about the monster to alarm the fishes as they swim by; the turtle's dull rough shell looks only like a muddy rock, especially since there are often bits of weed growing here and there upon it. But suddenly an ugly head darts out at the end of a long, snaky neck, and the frightened fishes scatter in all directions—all but one, who stays behind, fast in the jaws of the snapping turtle!

On land the snappers are very awkward.

They waddle along slowly with head, neck, and tail stretched straight out. After taking a few steps they nearly always fall down flat—and there they stay and rest for a while before hoisting themselves up and proceeding on their way. But the creatures seldom leave their watery home, though the mother always comes ashore to lay her eggs. She sometimes wanders a mile or more inland before she finds a spot to suit her, on soft marshy ground; then she digs a hole, lays her eggs in it, and makes a nice mud pie on the top of them.

### The Meanest Turtle in America

The alligator snapping turtle is even larger and fiercer than the common snapper. Its head is as large as the head of a bull terrier, and its jaws will snap a thick walking

## FRIENDLY TORTOISE AND SURLY SNAPPER

stick in it or bite a piece right out of a wooden plank an inch thick. It is as savage as the wildest beast of prey, and its temper is ferocious. It hisses angrily and snaps viciously at anyone who annoys it, and since a full-grown alligator snapper is quite capable of cutting off a man's hand with its terrible jaws, it is just as well not to interfere with the brute. Fortunately it is slow and clumsy in its movements. It waddles about, raised high on its thick legs, both in and out of the water, and if it misses its mark when it snaps at its prey, it is almost sure to lose its balance and stagger about in the most ridiculous way.

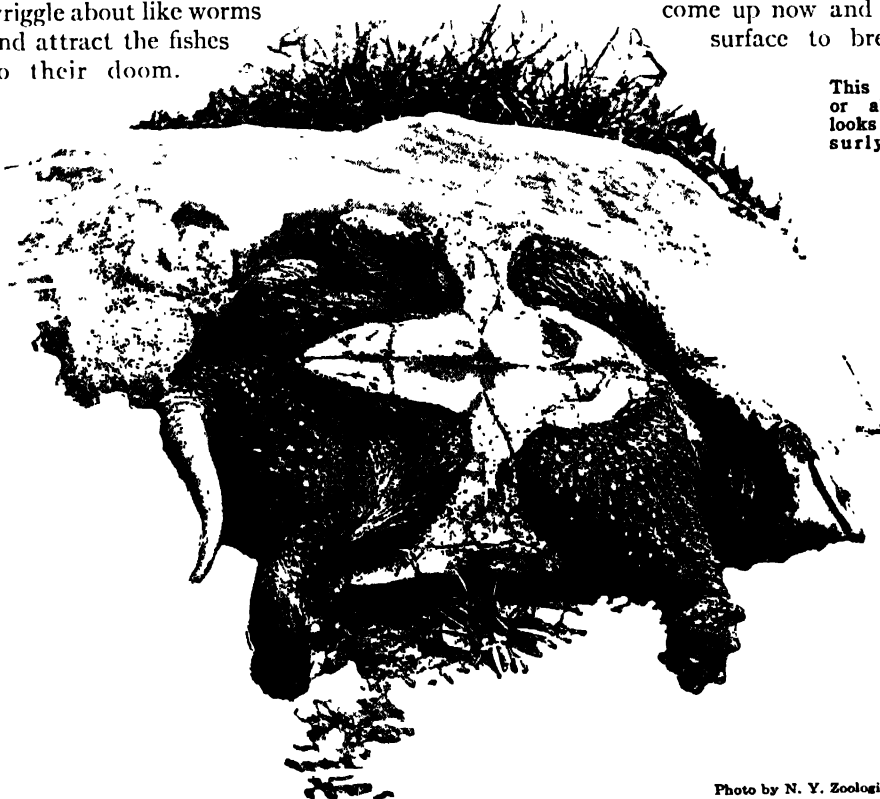
### A Fisherman among the Turtles

This creature lives in the Mississippi and Missouri rivers, where it destroys a great many fishes and ducks and makes itself a general nuisance. When lying in wait for prey, half buried in the mud, a snapping turtle dangles two red threads from the tip of its tongue which wriggle about like worms and attract the fishes to their doom.

The true sea turtles are quite different creatures. They also are giants of their kind and have very strong jaws. But they feed chiefly on seaweeds, though now and then some of them will take a meal of clams, oysters, or other shellfish as a change from a vegetable diet.

### Feet That Are Made for Swimming

A turtle's shell is flat and heart-shaped, and the upper and lower halves are never joined together like the shell of a land tortoise, though the carapace is covered with thin horny shields in the same way. Instead of clubbed feet, it has four long flat flippers which move slowly and gracefully as it swims through the water, though they are very awkward things to walk with when it comes ashore. But the sea is the turtle's true home. There it is quite in its element. It lives, feeds, and sleeps in the sea, and is often seen hundreds of miles from land. Turtles can stay under water for quite a long time, but are obliged to come up now and then to the surface to breathe; when



This snapping turtle or alligator-terrapin looks rather like a surly bear when turned over, as here, on his back. We can see how much he has out-grown his horny coat of mail. We can see, too, his vicious hooked beak, and the alligator-like tail that gives him his name.

Photo by N. Y. Zoological Society

## FRIENDLY TORTOISE AND SURLY SNAPPER

swimming they usually hold their heads well above the surface, and when they dive below, their nostrils are closed by two little shutters to keep the water from flowing in.

All true turtles live in the warmer seas of the world and they are all very much alike in their ways. The green turtle—whose fate it is to be served up as soup if it is caught while taking a stroll on the beach—often wanders into colder waters, and during the summer is sometimes seen in New York harbor.

The male turtle seldom leaves the safety of the seas, but the female comes ashore to lay her eggs on a low sandy coast or an uninhabitable tropical island. She usually chooses a fine moonlight night for this. After a cautious survey of the land she hauls herself out of the water and flops upon the shore with a loud hissing noise to frighten any enemies that may be about.

### Hardships of a Baby Sea Turtle

Once safely landed, she makes her way up the beach, floundering along on her flat flippers in a most ridiculous way until she gets to a dry spot beyond the reach of the highest tide. Here she scrapes and scuffles in the sand, digging with her front flippers and using the hind pair as shovels to fling the sand out several feet behind her. After a good deal of groveling and shoveling, the turtle succeeds in making a large, deep hole, and in this she places a hundred or more eggs. She then covers them, carefully smoothing and leveling the sand on top of them, and waddles back to the sea again.

In about two months, if all goes well, the heat of the sun hatches the eggs and the baby turtles scramble out of their sandy

nest. But no sooner do they show their absurd little flippers above ground than their troubles begin. The tiny creatures at once make for the water, and as they shuffle and scuffle along, the sea hawks, frigate birds, and sea birds of all kinds are after them. The big land crabs join in the chase, and few indeed of the hundreds of wee turtles who start on that perilous journey succeed

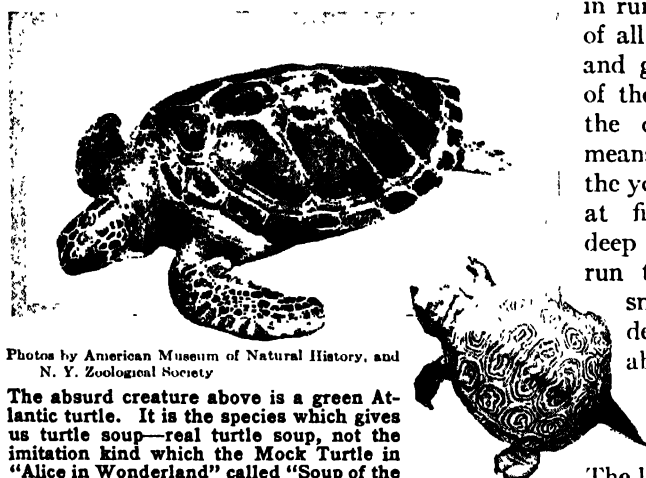
in running the gauntlet of all their hungry foes and gaining the safety of the sea. Even then the danger is by no means over, for although the young turtles do not at first venture into deep water, they now run the risk of being snapped up by wandering fishes. Probably only one or two of the little creatures live to grow up.

The loggerhead turtle is very much like its cousin, the famous green turtle, but it is rather larger and has a much bigger head, while its beak is hooked instead of rounded at the tip. A full-grown loggerhead may have a shell four feet long and weigh five hundred pounds or more. But it is not good to eat, and its shell is of no value; so it is not persecuted in the same way as the poor green turtle.

Most valuable of all the turtles is the hawksbill. The shields on its carapace are smooth and clear, and beautifully marked with yellow and black. They are the real "tortoise shell," and they grow only on the back of the hawksbill turtle. No other turtle or tortoise has such a valuable shell.

### A Giant among the Turtles

Largest of all the turtle tribe is the huge leathery turtle. It is not a bit like its relatives except in shape. It has a huge head and flippers like any other turtle, but under the soft leathery jacket there is a mosaic pavement of small tile-like bony plates, covering the backbone and ribs. Even the head and flippers are covered



Photos by American Museum of Natural History, and N. Y. Zoological Society

The absurd creature above is a green Atlantic turtle. It is the species which gives us turtle soup—real turtle soup, not the imitation kind which the Mock Turtle in "Alice in Wonderland" called "Soup of the evening, beautiful soup." The flesh of the diamond-backed terrapin at the right is a great delicacy, also.

## FRIENDLY TORTOISE AND SURLY SNAPPER



Photos by N. Y. Zoological Society, and American Museum of Natural History

## FRIENDLY TORTOISE AND SURLY SNAPPER

merely with smooth skin, and not protected by bony plates or horny shields as the heads and limbs of the true turtles are.

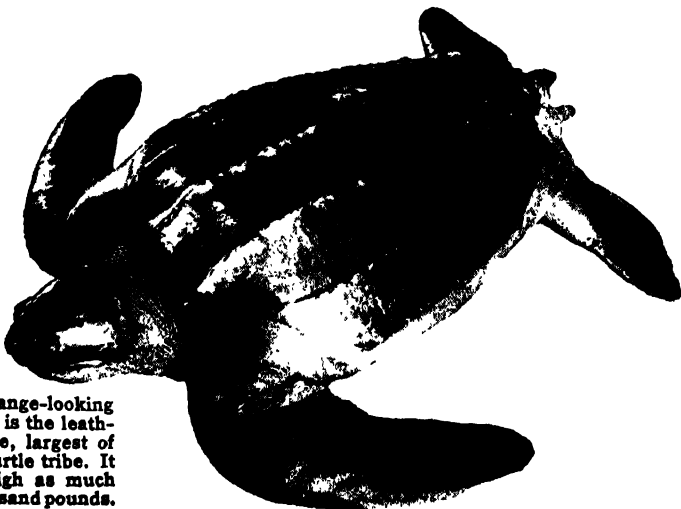
This sea giant is sometimes more than six feet long and may weigh a thousand pounds. Although it is so big and bulky, it skims through the water as gracefully as birds fly through the air, its long, powerful flippers moving like wings. It wanders about the warmer seas in both the Old and New World, and the Gulf Stream sometimes brings it as far north as the coasts of Long Island or Massachusetts. But the colder waters do not agree with the leathery turtle. It gets chilled and torpid, and in stormy weather is tossed on the beach by the rough waves.

This strange turtle is quite harmless, but it is also quite useless. It is unfit for food, and its flesh is said to be actually poisonous. It never comes on land except to lay its eggs. Although all sea turtles have large families, the leathery turtle has the largest of all, for the mother lays about three hundred and fifty eggs—in two batches. But her young ones meet the same sad fate as the little green turtles. They are nearly all gobbled up by birds and crabs and fishes almost as soon as they are hatched.

There are several other odd turtles and tortoises in various parts of the world. There are queer "snake-necked" turtles or

"side-necked" turtles which have such snaky necks that they cannot be drawn back under the shell in the usual way but have to be tucked in sideways. One of the turtles that lives in South American rivers and streams looks just like a flat round stone with an ugly snake sticking out beneath it, as it lies basking in the sun with its flat head and long neck stretched out in front of it. This turtle has a shell about seven inches long, but another snake-necked turtle, called the "matamata," is eighteen inches long, and is one of the most grotesque creatures you could imagine. Its shell is all humps and bumps, its long snaky neck is covered with knobs and flaps of ragged-looking skin, while two folds of skin stand up like ears on the top of its head! This strange reptile is a native of Brazil and Guiana, but there are other snake-necked turtles in Australia and New Guinea.

Then there are the soft-shelled tortoises, strange, flat, flabby animals with no real shell at all. They live in rocky places in East Africa, where they squeeze themselves under the stones and then slightly inflate their baggy bodies to make it impossible to pull them out. There are also several kinds of soft-shelled turtles in North America, where they are caught and eaten in great numbers. The edible turtles always have a pretty hard time.



This strange-looking sea craft is the leathery turtle, largest of all the turtle tribe. It may weigh as much as a thousand pounds.

Photo by American Museum of Natural History

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# REPTILES

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## Reading Unit No. 7

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### THE GRACEFUL AND TERRIBLE SERPENT

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

How snakes glide along the ground, 3-482  
How snakes shed their skins, 3-482-83  
Why all animals dislike snakes, 3-483  
How snakes can swallow victims

larger than themselves, 3-484-85  
The deadly Indian cobras, 3-485-87  
The mongoose, 3-486  
Snake charmers, 3-487

#### *Things to Think About*

How do the ribs of a snake help it to move?  
Why do snakes shed their old skins?  
How many people die each year of snake bite in India?  
How is the snake's mouth fitted

for swallowing victims wider than it is?  
How does a mongoose kill a cobra?  
How is it possible for snake charmers to handle cobras?

#### *Picture Hunt*

How does the harmless puff adder scare away an enemy? 3-482  
What makes the rattlesnake so deadly? 3-483-84  
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ans had their fangs removed? 3-486  
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#### *Leisure-time Activities*

PROJECT NO. 1: Visit the snake section at the zoo or the museum. Observe the skeletons

of snakes, especially the heads of poisonous ones. Learn how snake bite is treated, 2-468.

#### *Summary Statement*

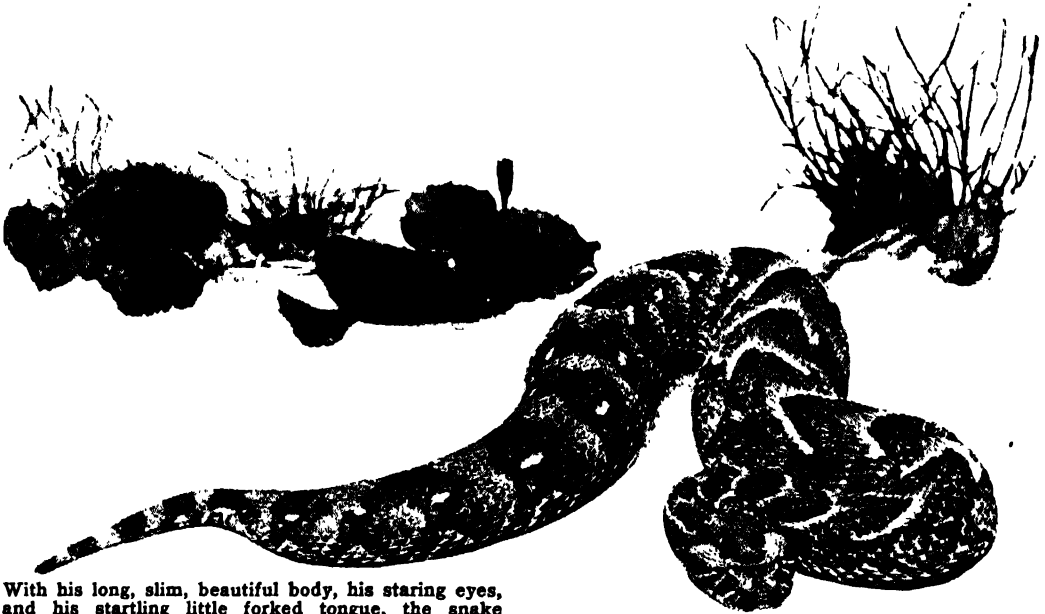
Most snakes are harmless to man. The poisonous ones have incurved teeth, called fangs, which are like hollow needles.

Poison travels through these fangs only when they are pressed into something.

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## THE GRACEFUL AND TERRIBLE SERPENT

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With his long, slim, beautiful body, his staring eyes, and his startling little forked tongue, the snake glides through the grass or across the sands. This one belongs to the family of adders or vipers, found over almost all the world. He is called a puff adder, because when he is excited he puffs himself up with a mouthful of air and then lets it out with a hissing sound.

Photo by N. Y. Zoological Society

## *The GRACEFUL and TERRIBLE SERPENT*

*Beautiful, Mysterious, and Sometimes Deadly, Snakes Are Feared by Man and Beast, Even When They Are Harmless*

**N**O MATTER how much we may fear them, snakes have a fascination for us all. They deserve to be called "reptiles" even more than do the lizards, crocodiles, and tortoises, for they are really "creeping things." A snake has no legs. It moves in a marvelous way, and seems almost to pour itself along the ground. It can glide swiftly forward in a perfectly straight line, or twist and turn and wriggle its way in and out among stones and rocks or the tangled scrub and tree trunks that bar its progress through the forests and jungles. It coils its long slim body into all sorts of graceful curves and loops. The snake can do this because its backbone is made up of hundreds of flexible joints, fitted one to another by a kind of ball-and-socket arrangement. This enables it to twist and writhe

and tie itself up into knots without dislocating its spine.

Attached to each of these joints—except the last one or two at the tip of the tail—is a pair of delicate curved ribs, and the free end of each rib is fixed to one of the horny scales underneath the body of the snake. As the animal glides along, the ribs are moved forward, one pair after another, with a kind of rippling motion, and the horny scales grip any rough, uneven spots on the ground. So the snake pulls itself along, and may really be said to walk with its ribs.

Snakes, like lizards, are clad in scales which slightly overlap one another like the tiles on the roof of a house. The scaly coat is protected by a thin transparent skin, running from the tip of the nose to the tip of the tail. Even the eyes, which have no



## THE GRACEFUL AND TERRIBLE SERPENT

eyelids and can never close, are covered with shields of skin, which look just like round watch crystals.

Several times a year a snake sheds its skin, for after a time the skin grows so tough and tight that the snake cannot breathe properly.

So to get



Here are the ugly heads of two of the most dreaded snakes of the New World. The open mouth of the rattlesnake, left, shows clearly its murderous fangs. The anaconda, below, is held securely just at the base of the head so that it cannot bite. The rattler, common in the United States, gets his name from the horny rattles at the end of his tail. The terrible anaconda, which lives in South America, is the largest living species of serpent; it is sometimes 30 or 35 feet long.



Photos by Raymond L. Ditmars by Courtesy American Museum of Natural History, and N. Y. Zoological Society

rid of it the animal rubs off the outer layer of skin against trees or rocks, or sometimes drags its body through a forked branch or between two stones. In this way it contrives to wriggle out of its old dead skin, turning the skin inside out as it goes, like the finger of a glove. We, too, lose the outer dead layer of our own skins, only it is constantly coming off in tiny flakes, instead of all at once.

### A Foe to Man and Beast

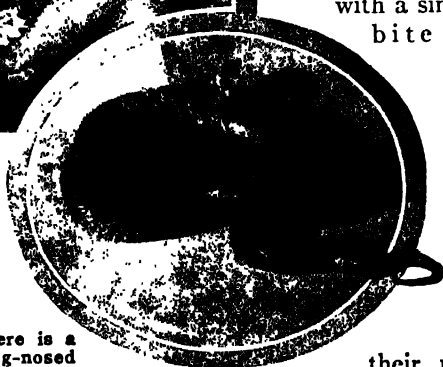
Of course if the snake rubs itself too roughly the skin will be rather torn, but sometimes it is shed in one piece, with even the "eyeglasses" in place; and you may see the mark of every scale upon it as it lies almost unbroken on the ground.

Snakes are not at all popular. They are feared and disliked by nearly everyone all the world over, and are the terror of all wild creatures living in the forests, swamps, and jungles of the warmer countries. There

really is something appalling in the stony stare of their cold, unblinking eyes, and in the silent, stealthy way they slither up to their prey. Almost all intelligent animals are afraid of snakes. Horses will shy at a snake, monkeys chatter and shiver at the sight of one, and few dogs can be induced to touch the slippery things.

And it is not without reason that these reptiles are hated and feared by almost all living things. There are many truly terrible snakes, both in the New and in the old World—deadly creatures that crush the life out of their victims or kill them with a single bite of

Here is a hog-nosed snake caught in the very act of shedding its old skin.



their poisonous fangs. The ugly rat-tailed viper is more dreaded in tropical America than the alligator or the jaguar, while in India thousands of people die from snake bite every year. Yet the snakes are not all dangerous; there are really many more harmless ones than venomous ones. But as it is often hard to tell which is which, it is just as well not to meddle with any of them unless we are very sure we know them. Some parts of the country are free of poisonous snakes, but they abound in other parts.

## THE GRACEFUL AND TERRIBLE SERPENT



Photo by Raymond L. Ditmars, Courtesy American Museum of Natural History

Have you ever picked up a bit of cast-off snake skin among the dry leaves in a wood or by some clump of sagebrush? How exciting to feel the fragile, transparent stuff crackle and fall apart in your fingers, and to remember that it once covered the glittering scales

and lidless eyes of some snake! But not often does a snake manage to wriggle out of his skin leaving it as perfect and whole as the one in this picture. No wonder the western striped snake that has done the trick is coiled up in the sun basking proudly!

There are many different kinds of snakes. There are ground snakes that hide in long grass or among rocks, and steal swiftly and noiselessly upon their prey. Some of them are poisonous and others are quite harmless. Then there are burrowing snakes, perfectly harmless creatures that live underground, like worms, in the dark. And there are tree snakes that make their homes in trees and bushes, coiling themselves round the branches, where, hidden by the thick leaves, they watch for their prey with glittering eyes. Some are poisonous and some again are not. Lastly there are the sea snakes and the fresh-water snakes. All the sea snakes are poisonous, while most of the fresh-water snakes that live in rivers and streams are harmless.

Even the snakes that are quite harmless to man can hardly be called harmless to the

other animals that they hunt and kill for food. Birds, beasts, lizards, frogs, and fishes all fall victims to these reptiles.



Photo by American Museum of Natural History

This is a picture of the mouth of a poisonous snake. Its teeth, like those of other snakes, are bent backward; that is why it has to swallow its food whole instead of trying to bite and tear it first. The wicked-looking but harmless forked tongue lies along the lower jaw. It is the crooked fangs above that do the deadly work. Poison from the poison gland runs through them into the victim's veins.

Some of them eat hardly anything but the eggs which they steal from the nests; but most of them will devour any living creature they can manage to swallow, while some are cannibals and dine on their own relatives when they have the chance.

Snakes never bite up their food. They swallow their victims whole; for although they have plenty of sharp teeth, as a rule the teeth all point backward, and cannot be used for tearing and biting. The two bones of the lower jaw are not firmly welded together in

the usual way, but are loosely connected by a sort of elastic band, so that each side of the jaw works separately. When the snake has seized its prey by the head, it

## THE GRACEFUL AND TERRIBLE SERPENT

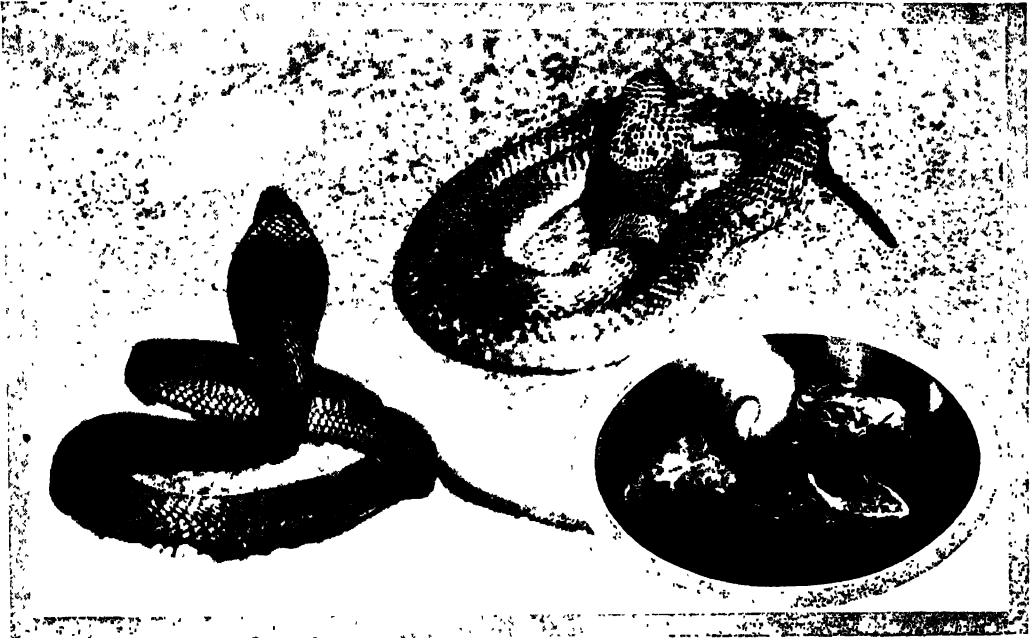


Photo by N. Y. Zoological Society

There are several species of cobra; all have the bulging neck, or "hood," and all are deadly poisonous. At the left above is an Egyptian cobra, one of the largest of the family. There is another African cobra which spits out its venom, always aiming at the eyes of its foe; if it hits them the man or beast may go blind for

the rest of his days. The Indian cobra above shows the markings on its hood which sometimes look like spectacles. Strange as it may seem, this fierce and venomous snake was once worshiped in parts of India. The oval shows a man grasping an Indian cobra between head and neck to force open its mouth.

moves each half of its jaw forward and backward in turn until it has gradually drawn the victim into its mouth and down its throat. It is really astonishing what a huge mouthful a snake can swallow. Its mouth opens wider and wider and its neck swells and swells until a meal that is often many times larger than its own head disappears down its throat. And when this feat has been accomplished you can see a great bulge in the creature's body as it rests and digests its meal.

### Do Snakes Ever Sting?

Many people think that a snake stings its victim with its tongue, which is long and black and forked at the tip, and flickers in and out of the reptile's mouth in a threatening way. But this is a mistake. A snake does not sting, it bites. Poisonous snakes have two long, curved, wicked-looking fangs in the upper jaw, with a poison bag at their base. These are deadly weapons. The fangs are either hollow, with a small round

opening near the top, or have a grooved channel down which the poison flows.

### The "Black Nag" of India

One of the most deadly of the poisonous snakes is the dreaded Indian cobra, or the "black nag," as the natives call it, whose bite will cause the death of almost any living creature within a couple of hours. This snake has several names besides "black nag." It is called the "hooded snake," from the way its neck swells out when it is angry, or ready to strike; and the "spectacled cobra" because on the back of the "hood" is a curious mark that looks a little like a large pair of spectacles.

This terrible snake is rather lazy during the hot hours of the day. It likes to coil up in the long grass in the forests and jungles until the cool of the evening. Sometimes it creeps under a rubbish heap or a pile of brushwood, or it may take up its quarters in some old ruin and hide away among the heaps of broken masonry. But

## THE GRACEFUL AND TERRIBLE SERPENT

woe betide anyone who passes too near and disturbs the slumbers of the black nag! With an angry hiss the creature puffs out its hood, darts forward like a lightning flash, and buries its poison fangs in the leg or foot of the intruder.

In the evening the black nag grows wide awake, leaves its hiding place, and goes "a-hunting." It eats frogs, lizards, rats, birds, or any small creatures that cross its path, and sometimes it goes fishing in the forest streams. It is a spiteful and bad-tempered reptile if it thinks it is threatened, always ready to strike at anything that seems dangerous, even though the creature may be much too big to swallow; so the snake often kills many an animal before it slinks home to bed.

A full-grown Indian cobra is about six feet long, but its cousin, the king cobra, often measures twelve or even fourteen feet from nose to tail. It is deadly and savage. Although it never eats anything but smaller snakes, it will strike at and kill any creature that crosses its path. Hunters dread the king cobra, for it is likely to hide in the long grass ready to dart at all who pass; and its bite means death to man and beast. Its poison will even kill an elephant.

Yet the deadly cobras have their own enemies. Wild pigs are very fond of young cobras and gobble them up with much relish, while jungle cocks and peafowls eat them too, and the poison appears to do them no harm. But the cobra's chief foe is the Indian mongoose, a small, furry animal, hardly bigger than a rat, with a long narrow head like a weasel's and a bushy tail that fluffs up to twice its ordinary size when its owner is angry.

The mongoose is a most warlike little creature. He hates snakes, and never sees one without wanting to kill it. Whenever

he meets a cobra or other poisonous snake, he quivers with rage. His hair stands on end, his tail fluffs up, and his eyes grow red and glittering as he dances round and round the reptile on the tips of his toes, watching for an opportunity to spring on its back and bite it in the neck.

Furious at being threatened in this way by so small an animal as the mongoose, the

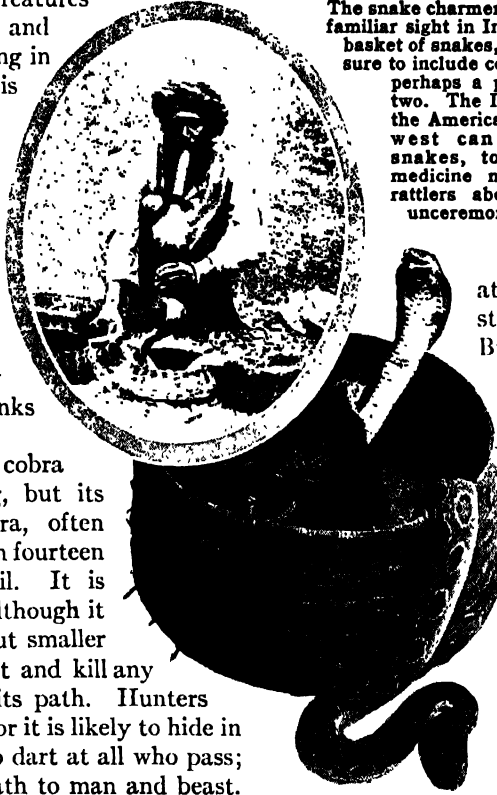
cobra spreads its hood and hisses angrily at the impudent little fellow. Its long black tongue flickers in and out of its jaws as it lashes out

at its enemy, trying to strike him a fatal blow. But although the snake's head darts about like lightning, the mongoose is just as quick on his four little feet. He springs backward, leaps aside or into the air, escaping the deadly poison fangs time after time by hardly so much as a hair's breadth. Then at last his chance arrives. With a sudden bound the little snake killer lands squarely on the back of the cobra and breaks its spine with a crunch of his strong little teeth.

Of course the mongoose does not always win the fight, but he very often does. And so bold and fearless is the small creature that he will attack a cobra four or five feet long and actually kill it too.

People in India often keep a mongoose to kill snakes, just as we might keep a cat to kill rats and mice. Cobras hardly ever enter a house; but the krait, a small dusty-brown snake whose bite is just as deadly, is fond of creeping indoors and hiding behind curtains or under beds. Fortunately the krait is

The snake charmer, left, is a familiar sight in India. His basket of snakes, below, is sure to include cobras and perhaps a python or two. The Indians of the American Southwest can handle snakes, too; their medicine men fling rattlers about most unceremoniously.



Photos by Raymond L. Ditmars, Courtesy American Museum of Natural History, and Grinnell Bros.

## THE GRACEFUL AND TERRIBLE SERPENT

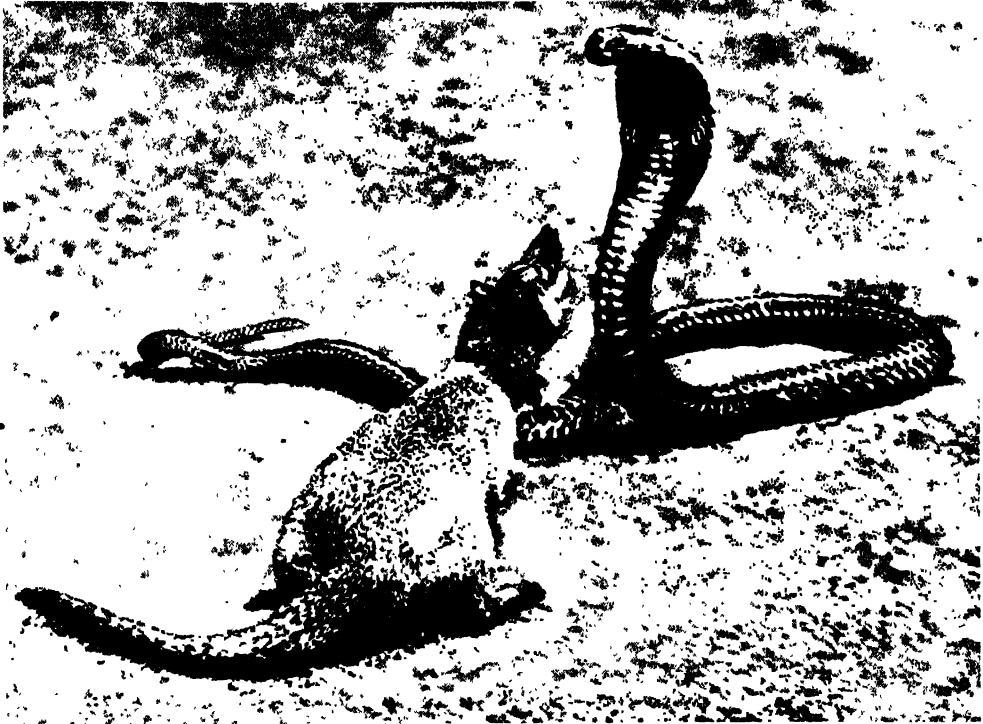


Photo by International

This shows the epic battle that is often fought between the mongoose and the cobra. The terrible serpent cannot strike swiftly enough to settle its fangs in the back of the neck

little mongoose. The valiant little creature leaps from side to side till the great snake is quite worn out. Then, when the opening comes, it seizes the cobra by and breaks its spine.

not so vicious as many other poisonous snakes and seldom attacks human beings unless it is frightened. If anyone happens to kick or step on the creature, however, it will strike. But no snake stays long in the same house with a mongoose.

Hindu snake charmers treat cobras in the most unceremonious manner. They pick them up, twist them round their necks, and make them "dance" to order. To be sure, most of the snakes have had their fangs drawn to make them harmless.

To make his cobras "dance," the snake charmer sits cross-legged on the ground with a flat round basket in front of him and begins to play a strange, crooning tune on his flute. This sound seems to fascinate the cobras; up from the basket come the wicked-looking heads, with hoods spread out and tongues flickering. They sway from side

to side in time to the music. Faster and faster the man plays, and faster and faster the cobras dance to his piping. Then suddenly the music stops and the snakes sink down into their basket again. Why they behave in this way, no one seems to know.

Snake charmers have to be very careful in handling their snakes, even when the fangs have been taken out, for in time these grow again. Many snake charmers do get bitten by the cobras, but they always carry an antidote to prevent the poison from taking full effect. Although they may feel ill for a time, they seldom die from snake bite.

Cobras are found in many parts of Southern Asia and Africa, though there are none in the New World. But there are other snakes whose bite is quite as deadly, both in North and South America.

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# REPTILES

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## Reading Unit No. 8

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### GOOD SNAKES AND BAD

*Note: For basic information not found on this page, consult the general Index, Vol. 15.*

*For statistical and current facts, consult the Richards Year Book Index.*

#### *Interesting Facts Explained*

Dangers from poisonous bush masters and rat-tailed vipers, 3-489-90  
The rattle of the rattlesnake, 3-492-93  
Rattlesnake dens, 3-492  
The poisonous snakes in North

America, 3-492-94  
Snakes that crush their victims to death, 3-494, 496, 498  
A snake that gives birth to living young, 3-498-500  
Snakes that help the farmer, 3-500-3

#### *Things to Think About*

Why must living things in tropical America always be on the alert?  
What poisonous snakes are found in North America?  
How do we know that snakes once had legs?  
Which is the commonest snake in

the United States?  
How does the hog-nosed snake frighten people?  
How are snakes useful to farmers?  
What do you think of people who kill every snake they see? ~

#### *Picture Hunt*

How can you identify the snake in this picture? 3-491  
How are some snakeskins used by man? 3-492-98  
What snake spits poison from its fangs? 3-493  
How long can a python fast? 3-494

Why must pythons and boa constrictors keep swallowing what is in their mouths? 3-496-99  
Why do boas like to hide in trees? 3-499  
What interesting fact about the garter snake do you learn from this picture? 3-501

#### *Leisure-time Activities*

PROJECT NO. 1: In order to learn to recognize a rattlesnake's warning, attach a rattle from a

dead snake to the clapper on an alarm clock, remove the gong, and let the bell "ring."

#### *Summary Statement*

Deadly snakes may kill their victims by poison or by crushing. Poisonous snakes have fangs like hypodermic needles. The crush-

ing is done by constrictors which are strongly built. Most snakes, however, are not only harmless, but useful in killing rats and mice.

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## GOOD SNAKES AND BAD

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Photo by N. Y. Zoological Society

Three men and some twelve feet of snake. A regal python, like this one at the New York zoo, is the Old

World edition of the boa constrictor. He has no poison fangs, but his embrace is deadly.

## GOOD SNAKES *and* BAD

*Snakes Are among the Best Friends That Man Has, but Some Are Deadly Enemies as Well*

**I**N THE gloomy depths of the forests of tropical America lives the terrible bush master—a fearful brute from nine to twelve feet long, with enormous poison fangs. Its bite is death. This great snake is the master of all the wild folk in the tangled forests in which it makes its home. None dare defy the monster. It fears no foe, and will even chase travelers if they dare to disturb it when it is lying coiled up in the grass in the daytime.

Fortunately the bush master seldom leaves its gloomy haunts in the uninhabited forest regions, but the equally ferocious and venomous rat-tailed viper invades the sugar plantations and is a great danger to the workers. This snake grows to a length of six or seven feet and has a pointed snout

shaped like the head of a lance. It spends the day hidden under a bush or in a hollow tree trunk, with its long greenish-gray body coiled round and round, and its head in the center ready to dart like a flash at anyone who disturbs its rest. At nightfall it wakes, slowly unwinds its coils, and crawls from its lair, lazily yawning and showing its cruel fangs. Then it slides noiselessly away, slipping through the grass and over the rough ground as easily as a stream of water flows through a channel. Night is the time when most of the wild forest folk come out to feed and drink from the pools and streams, and the snake is sure of finding something for supper.

Perhaps a little agouti (â-gōō'tl)—a small beastie that looks like a deer but is no bigger than a rabbit—may be peacefully nibbling

## GOOD SNAKES AND BAD

the herbage all unaware that danger is near. Suddenly a long shadowy form glides noiselessly up to the little creature; and before he has time to bound away an ugly flat head shoots forward and the cruel fangs of the serpent pierce his tender skin. The terrified animal turns to flee, but the poison fangs have done their deadly work. The agouti staggers a few steps and falls to the ground. Then the snake creeps up, noses its victim to see that he is dead, and calmly proceeds to swallow him whole in the usual snakelike fashion.

Danger lurks everywhere for small defenseless creatures in the dark forests. While the rat-tailed viper hunts its prey beneath the trees, its cousin, the horned palm viper, creeps about the branches overhead and seizes young birds with a deadly grip. It holds its fluttering victims fast with its long curved fangs until the poison takes effect and their struggles cease.

The horned palm viper is a small, slender snake with a heart-shaped head and a beautiful green scaly coat marked with spots and splashes of black and pink, or red. It makes its home in tropical America, and sometimes travels north as a stowaway in a bunch of bananas. But although this southern visitor looks so pretty and appears so quiet and gentle, it is really a most poisonous reptile.

The horned palm viper is a "pit viper"—one of the family of venomous snakes which have a deep pit on each side of the snout,

In the oval is Russell's viper, an Indian snake so poisonous that snake charmers who have no fear of cobras will give this viper a wide berth. It is black and brown in color, and is said to strike with such force that its entire body leaves the ground. It hunts by night.

just below the eyes. True vipers are found only in the Old World. They are all poisonous snakes and are greatly

feared in Southern Europe, Asia, and Africa. The famous horned viper of the Desert of Sahara is supposed to be the "asp" which killed Cleopatra. It is a beautiful little serpent, with bright, catlike eyes and two funny

little scaly horns on the front of its head.

The puff adder of Africa is one of the most dangerous vipers. It is nearly six feet long and as big as a man's arm. It loves to lie half hidden in the sand and strike at any creature that passes by. Its huge flat head and cruel stony stare are enough to terrify all who see it, and there is little hope for anyone who ever feels its cruel fangs. In old days the Bushmen of South Africa dipped their arrows in the poison of this reptile. The British viper, or adder, is not so deadly, though its bite will make a person seriously ill. It is about two feet long and is the only poisonous snake found in Britain.

A very beautiful but extremely poisonous snake is the harlequin coral snake of Mexico and the southeastern part of the United States. It is hardly a yard long and is clothed in glittering scales ar-



Photo by  
N. Y. Zoological  
Society

The horned viper, shown in the square, likes to bury itself in the sand of the Sahara, with its horned head just sticking out. This is thought to be the serpent that brought death to Cleopatra. The ancients feared it more than any other snake. Below the horned viper is the sand viper, or long-nosed viper, of Southern Europe and Asia Minor. On its snout is a long, scaly appendage which gives the snake its name.

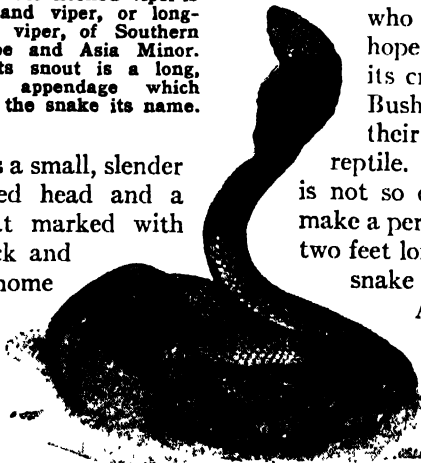


Photo by N. Y. Zoological Society

This is the asp, a kind of cobra that lives in Egypt.



## GOOD SNAKES AND BAD

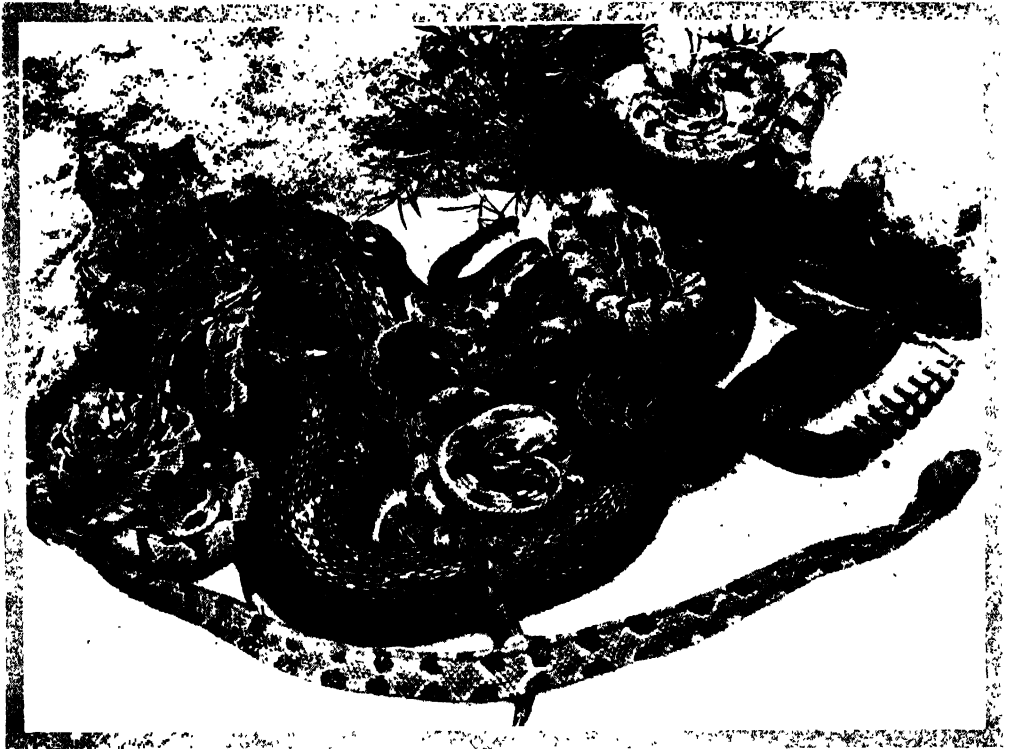


Photo by Raymond L. Ditmars Courtesy American Museum of Natural History

Here is a lumber rattlesnake surrounded by her happy family of ten or eleven promising children—it is hard to say just how many. As they grow up they will shed their skins from time to time, until at last they

will look just as she does—and will have as many rattles on their tails. When winter comes they will hibernate with other rattlers; thousands of the charming creatures used to gather in a single cave.

ranged in broad bands of scarlet and black divided by narrow yellow rings. It seems so quiet and harmless that people who are not acquainted with its manners often pick the pretty creature up when they find it wandering about in damp woods or in sweet-potato fields, where it is fond of burrowing. Then, instead of hissing and striking, as most snakes do if they are interfered with, the coral snake quietly fixes its jaws into the hand that holds it, and, without any warning, gives a sudden vicious bite.

In spite of their rather small size and their deceptive ways, all the pretty coral snakes are dangerous creatures. The South American coral snake is rather larger than its northern cousin. It has a gorgeous suit of bright red scales marked by broad black bands and narrow rings of pale yellow, and it is quite as cunning and vicious as the harlequin coral snake.

The North American rattlesnake behaves

in quite a different manner. He, too, is a dangerous reptile; but when on the warpath, he warns everybody to get out of his way by vigorously shaking the rattles at the end of his tail.

### America's Most-Feared Snake

A big rattlesnake makes such a noise with its rattle when it is about to strike that one might expect all the timid creatures in the neighborhood to be scared away and leave the snake without his supper. But this does not seem to be the case. The rattler appears to fare quite as well as snakes who glide up to their prey like silent shadows. Possibly many small wild animals do not know what the rattling noise means and do not try to make their escape until it is too late; or it may be that they stand still to listen and are struck. Very large animals, like the buffalo, may have learned to beware of the sound and to run off when they hear it.

## GOOD SNAKES AND BAD

The snake's rattle is made up of a number of loose horny rings inside the skin at the end of the creature's tail. At first the young rattlers have only one little bone button at the tip of their tiny tails, but ring after ring is added as they grow. An old rattler may have as many as twenty rings in his rattle, and make as much noise as a loud electric buzzer or a cicada.

Most rattlesnakes live in sandy places, especially where the ground is well covered with low bushes. They are rather lazy in the daytime, and are fond of basking in the sun when the weather is fine. When it rains they stay in a hole in the ground, for though they will sometimes take to the water in pursuit of prey they do not like to get wet in the rain. They often take possession of burrows made by chipmunks and prairie dogs. People used to believe that the snakes shared their homes with these little animals and lived with them in friendly fashion, but the story is not true. It is probably the sad fate of most of the little creatures to be eaten up by the snakes who come to seize their underground homes.

### Our Four Poisonous Snakes

In the cold months of the year numbers of North American rattlesnakes may be found fast asleep in dry caves and holes in the ground, all huddled up together in a tangled mass for the sake of warmth. In bygone days, when there were many more snakes in the land than there are now, thousands of these reptiles passed the winter in the same den. As soon as the days grew cold, they came together from far and wide, many of them traveling twenty miles or more to reach their winter quarters. And every year at this time hunting parties

used to set forth to visit the snake dens and kill the dreaded rattlers while they were numb and torpid with the cold.

The "diamond-back" is the largest and most dangerous of North American rattlesnakes. It is a handsome creature, often more than eight feet in length, with enormous poison fangs whose bite is usually fatal. Just after it has shed its skin, its shiny scales are a beautiful dull green or golden brown marked with a diamond-shaped pattern in lighter gold.

The coral snake, the rattlesnake, the moccasin or cottonmouth, and the copperhead are the only really poisonous snakes in North America. The cottonmouth, or water moccasin, is a stout, heavy snake with an ugly, wicked-looking head. It is at home either in or out of the water, and feeds on fishes and frogs, birds and small beasties, or on smaller snakes—in fact, on any creatures it can catch.

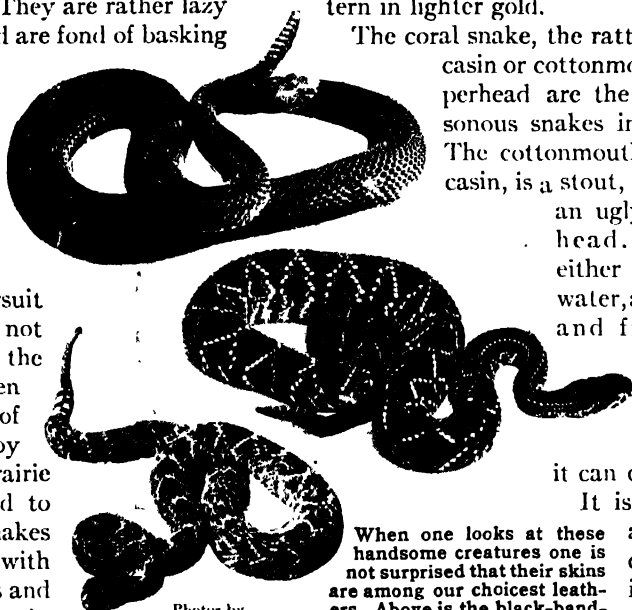
When one looks at these handsome creatures one is not surprised that their skins are among our choicest leathers. Above is the black-banded rattlesnake; in the center is the terrific, or South American, rattlesnake, the only one found south of Panama; and at the bottom is the Texas rattlesnake, a handsome fellow, though not so beautiful as the diamond rattler of Mexico, the finest and largest of all.

It is a deadly reptile, and looks very vicious when it opens its mouth to hiss and shows its terrible fangs. It is fond of sunning itself on the bank of a stream or coiling itself on an old twisted tree over-

hanging the water. If disturbed, it slips from its perch and slides into the water so smoothly that it makes no splash and only a few bubbles mark the spot where it has disappeared.

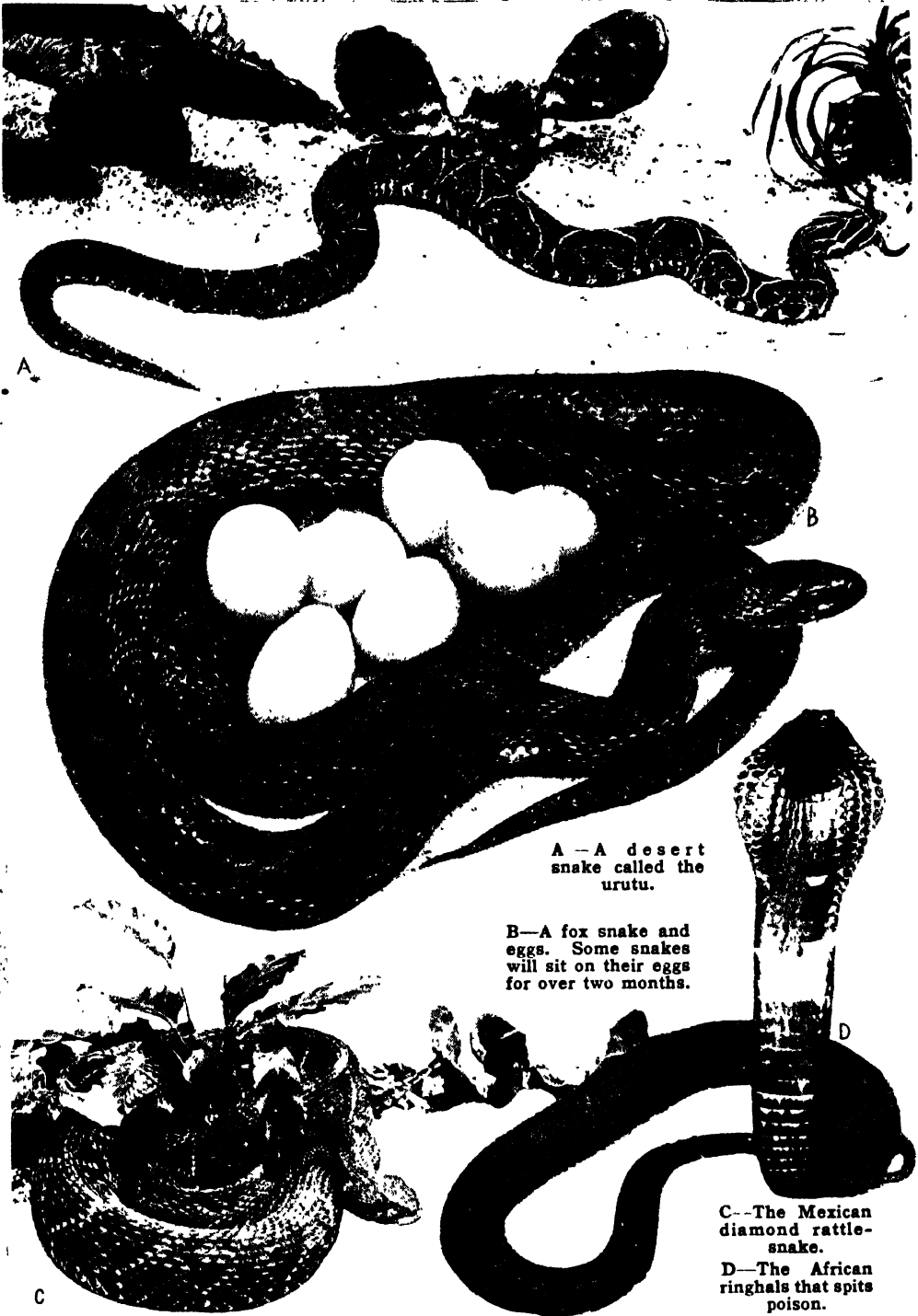
### Snakes That Crush Their Prey

The copperhead, or highland moccasin, prefers the damp forests, shady meadows, or plantations, and may sometimes be seen lying coiled up on the ground and looking like a small heap of autumn leaves. It is a rich reddish brown, with light



Photos by  
N. Y. Zoological Soc.

## GOOD SNAKES AND BAD



Photos by N. Y. Zoological Society and Raymond L. Ditmars Courtesy American Museum of Natural History

## GOOD SNAKES AND BAD

patches, and it has a bright copper-colored head. Although it is armed with deadly fangs, the copperhead is a timid snake, and will glide swiftly away and hide in the grass or the bushes instead of showing fight if you surprise it while it is taking a rest.

It is not only venomous snakes that are dangerous. The wild creatures of the forests and jungles have plenty

a splendid fellow clad in a wonderful suit of glittering black and yellow. It is a gigantic creature measuring from fifteen to twenty feet, and sometimes even thirty. So strong is this appalling reptile that it can overpower and crush to death full-grown deer, and even kill leopards and young tigers. Terrific battles occasionally take place between a

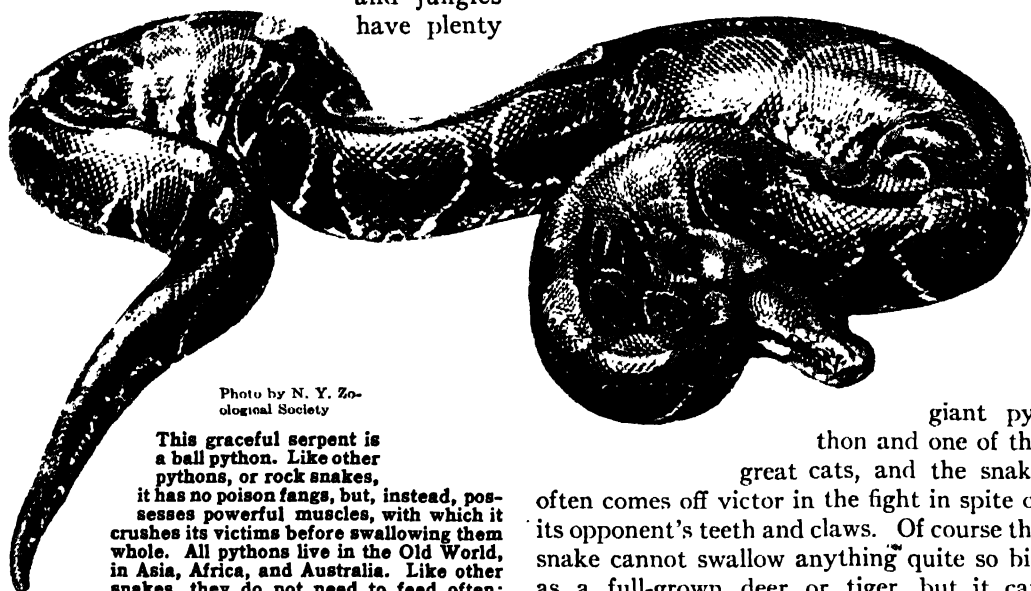


Photo by N. Y. Zoological Society

This graceful serpent is a ball python. Like other pythons, or rock snakes, it has no poison fangs, but, instead, possesses powerful muscles, with which it crushes its victims before swallowing them whole. All pythons live in the Old World, in Asia, Africa, and Australia. Like other snakes, they do not need to feed often; one good meal can last them many months.

of reason to fear the terrible pythons and boas, although their big fangs are not poisonous. These snakes kill their prey by "constriction." That is to say, they instantly crush the life out of their victims by coiling round and round them and suddenly squeezing them to death.

Pythons and boas are very much alike in their ways, but pythons are Old World reptiles, while boas are found chiefly in the warmer parts of America. The largest snakes in the world belong to these "constrictors." They are all distinguished by having two queer little horny spurs near the base of the tail—which are really the last remaining remnants of the legs their ancestors used to own in far-off, prehistoric days. Many other snakes have traces of tiny legs before they hatch, but lose them before entering the world.

King of the pythons is the regal python—

giant python and one of the great cats, and the snake often comes off victor in the fight in spite of its opponent's teeth and claws. Of course the snake cannot swallow anything quite so big as a full-grown deer or tiger, but it can manage a small antelope or a wild goat without much trouble, for its skin will stretch in the most astounding way to accommodate the huge morsel. A python will eat almost any small animals, such as rabbits and hares, sheep, pigs, and goats; it is very fond of birds, too, which it swallows feathers and all. After a large meal the monster is very lazy and torpid, and has to rest for a week or two before it is fit to go hunting again.

### The Hindu Snake Charmer

The Indian python is not quite so enormous as its regal cousin—who lives only in the steamy forests of Burma, Siam, and some of the East Indian islands. But it is quite big enough. Pythons ten or twelve feet long are quite common in India, and some hoary old specimens measure as much as fifteen or even twenty feet. These snakes are easily tamed when they are young, and

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Photo by N. Y. Zoological Society

This imperial python has draped himself in a tree, where he is well concealed among the leaves by his broken markings. Some kinds of python grow to be twenty-five feet long, and may have as many as 400 vertebrae. Pythons are always swift and graceful,

though when we see them in northern zoos they seem sluggish enough on account of the cold climate. A snake walks with its ribs, for the tips of each pair are attached to a scale that runs across the snake's abdomen, and these scales carry the snake forward.

## GOOD SNAKES AND BAD



The python in the upper picture looks uncomfortable but is really very contented, for it has just made a meal of a buck, which, after the manner of snakes, it has swallowed whole. In the picture just below, the serpent has been robbed of its buck—and of course of life as well. So strong were the snake's digestive juices that although the buck was removed almost at once, the processes of digestion had already begun. Snakes can swallow creatures much larger than themselves because their jaws can separate at the back of the mouth, which in this way can be stretched enormously.

One python in a zoo swallowed its blanket, apparently quite by accident. It just got the blanket in its mouth and had to keep on swallowing. In another case two pythons grabbed the opposite ends of a rabbit. The swallowing machines began to operate, and when the two heads met, neither could let go. So the larger snake swallowed on and on till it had completely enveloped its companion.

Hindu snake charmers play with them and wind them round their arms and bodies without fear of being hugged too tightly by the strange pets. But of course they do not take such liberties with an old fifteen footer. Only half-grown pythons are ever used for these snake-charming exhibitions.

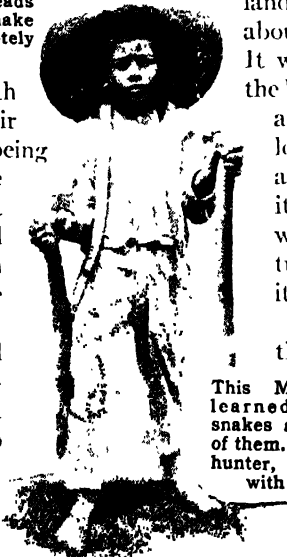
Nearly as big as the giant regal python is the anaconda (ăn'ă-kôn'dă), or water boa, of tropical America, which is said to grow to over thirty feet. But the length of all the great snakes is often much exaggerated; occasionally one may be seen of such huge dimensions, but the



Rhodesia Pubhlicity Co

raised above the surface, waiting for some unlucky little creature to come to the pool to drink. It is quite at home on land, however, and will often roam about the forests in search of prey. It will even climb trees and coil in the branches, to dart down and grab any small beast that may pass below. It will kill and eat all small animals or fish that it can seize in its jaws and crush in its coils; and will often squeeze to death creatures that are much too large for it to swallow.

The most important member of the boa family is the boa constrictor of South America. It is a fine, handsome snake, about ten or



This Mexican lad early learned to understand snakes and to be unafraid of them. Now he is a snake hunter, and is shown here with one of his prey.

eleven feet long when full-grown, with a shiny polished coat of red-brown, tan, and

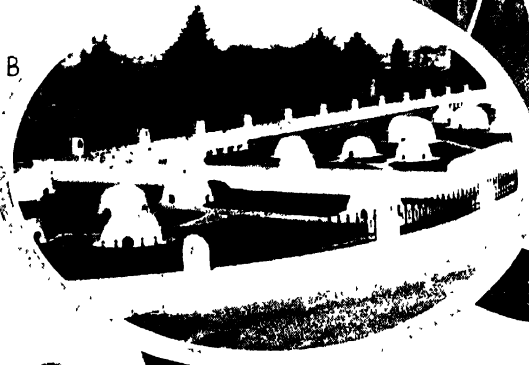
Photo by American Museum of Natural History

## GOOD SNAKES AND BAD

A—Eggs of the indigo snake.



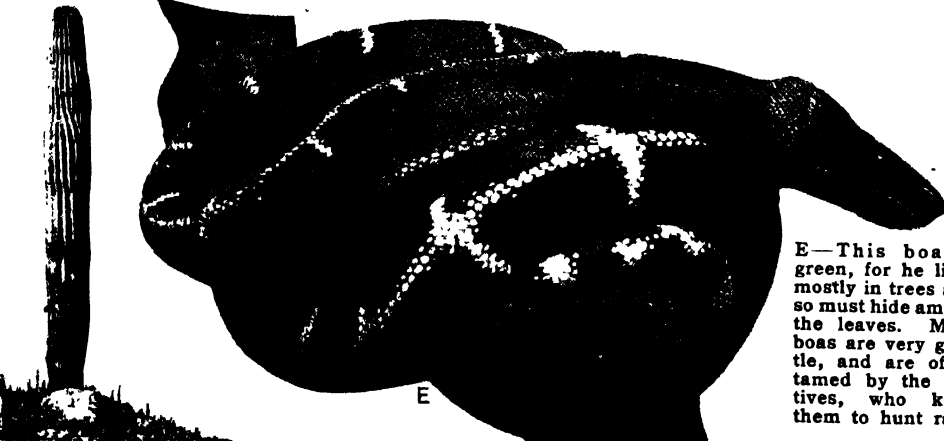
B—All these domes are the snakes' private residences in the serpentarium at São Paulo, Brazil. In that inclosure poisonous serpents are kept in order that their venom may be extracted and used to make serum for treating snake bite.



C—An attendant holding a poisonous snake in the proper way.



D—The gallant king snake, foe to all other snakes, is immune to their poison.



E—This boa is green, for he lives mostly in trees and so must hide among the leaves. Most boas are very gentle, and are often tamed by the natives, who keep them to hunt rats.

Photos by Raymond L. Ditmars Courtesy American Museum of Natural History, Field Museum, and N. Y. Zoological Society

## GOOD SNAKES AND BAD

tangled up together in a bunch. You may know these snakes by the three yellow stripes that stretch from head to tail along their slim dark bodies.

Although there are some exceptions to the rule, most snakes lay eggs. The eggs have soft, leathery shells and are usually

eggs too. This is a remarkable reptile, it is up to all sorts of tricks. In the first place, although it is really quite harmless, it looks so viperish with its short, thick body, stumpy tail, and ugly flat head that many people insist that the creature must be poisonous. Then, if you are bold enough to

attempt to capture the cunning reptile, it hisses and strikes, lashes its tail, and puffs out its neck as if it were trying to turn itself into a cobra. If this fury does not scare you



Photos by N. Y. Zoological Society and H. E. Zimmerman

left to hatch under heaps of decaying leaves and rubbish which act as natural incubators. But pythons and certain other snakes coil themselves round and round

their eggs, making a regular nest of their own bodies. And so they lie patiently with their heads resting lightly on the top until the eggs are hatched and the wee snake-lings wriggle out. Boas bear their young alive, a large family at the same time.

The dainty little creature above is a tree snake from Santo Domingo. You will notice that it has disposed itself quite comfortably upon a leaf. Tree snakes are always slender, with tapering tails. They always are expert climbers. The sausagelike fellow at the right is a sand boa. He likes to burrow into the sand, where he finds worms and lizards and similar dainty tidbits. There is no narrowing between his head and his body, to retard his progress underground.



The pine snake, sometimes called the "bull snake," is a careful mother who hatches her young from eggs. It is a handsome black and yellow reptile living in the dry pine woods of Southern North America. Unlike the snakes that can only hiss when they are excited or angry, the bull snake makes a loud bellowing noise that can be heard quite a long way off.

The curious hog-nosed snake, which also makes its home in pine woods, guards its

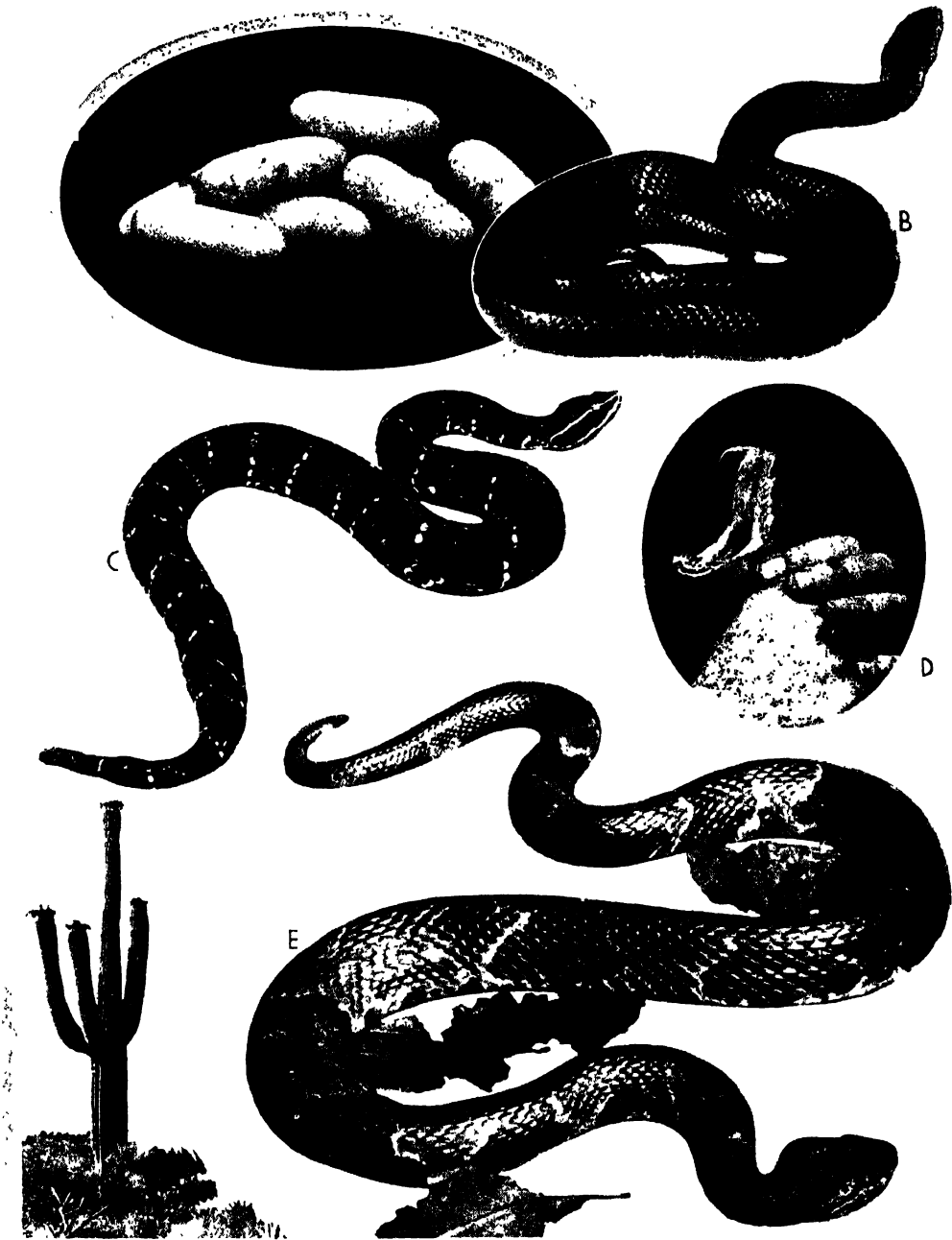
away, the wily "hognose" stops raging and proceeds to "play 'possum." Quite suddenly it rolls over on its back and lies limp and motionless just as if it were dead. So long as you remain near it, the snake will not attempt to move; but if you hide and watch, you will see it turn over again the moment it thinks all danger is passed and make off as fast as it can wriggle. But all this is sheer bluff. The hognose is really a good-tempered reptile. It cannot be induced to give you so much as a nip even if you put your finger in its mouth.

### Snakes That Help the Farmer

Many of our snakes are useful in helping to keep down the rats and mice that swarm



## GOOD SNAKES AND BAD



Photos by Raymond L. Ditmars Courtesy American Museum of Natural History, N. Y. Zoological Society, and Field Museum

In the oval, A, are the eggs of the handsome black snake, shown at B. She is perfectly harmless, and leaves these leathery-skinned eggs to hatch by themselves in some warm, moist place. The same compliment cannot be paid to the water moccasin, at C. It is handsome, to be sure, but its bite is deadly. It is about two feet long, and can live either on land or in the water. At D is a close view of its open mouth,

showing the curved poison fangs in front. In all poisonous snakes the fangs have a groove or canal down which the poison flows from a gland at the base of the fang. At E is the copperhead, or highland moccasin, another poisonous snake, living farther north than the water moccasin, which inhabits our southern states. These two moccasins, the rattlesnake, and the coral snake are the only poisonous serpents we have.

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in farmyards and fields. But they seldom get the credit they deserve, for they are nearly always suspected of evil intentions. The chicken snake of the southeastern states is always accused of stealing poultry. It may indeed take an egg or two, or a very young chick now and then, but it really goes into the poultry yards to catch the troublesome rats and mice. So it is a blessing in disguise to the farmer. This snake is often six feet long and has a slim yellowish body with four dark stripes running from head to tail.

### Do Snakes Milk Cows?

The tales told of the milk snake are even more untrue. The harmless little reptile, hardly a yard long and no thicker than a broom handle, is accused of stealing into the farmyards and milking the cows! Of course this is ridiculous. The little green snake is only hunting for mice.

There are a great many beautiful and harmless snakes in North America. The corn snake of North Carolina is one of the handsomest. It grows to a length of five feet and is gorgeous in orange and crimson, with black and white markings. The green snakes are dainty creatures in beautiful leaf-green suits, which make them very difficult to see when they lurk in their favorite hiding places among bushes growing on the borders of meadows. These pretty snakes are very gentle and do not try to bite when they are

handled; and they feed on grasshoppers, smooth caterpillars, and spiders.

We must not leave out the king snake; for besides being one of the handsomest reptiles of North America, it is very intelligent and makes a most interesting pet. The king snakes are not all exactly alike. In Florida, where they are quite common, they are jet black with narrow white or yellow lines in a kind of chain pattern. In the lower Mississippi Valley they have a pale green spot in the middle of each scale; while in the southwestern states some of them are brown with yellow bands.

Although the king snake is so gentle that you may handle it without fear of being bitten by its sharp teeth, it is by no means timid. It wages war on all other snakes, big and little. It will even attack deadly rattlesnakes, copperheads, and moccasins several times as large as itself; and strange to say, the venom of these poisonous reptiles does the gallant king snake no harm. It is a cannibal and eats any snakes smaller than itself except its own kind. King snakes never fight one another, and several of them will live peaceably together in the same cage.

It is a great pity that people kill snakes so savagely, for most of us are in small danger of meeting a poisonous one, and the gentle little creatures that dart across a woodland path are excellent friends to man. Like so many things in this world, they need only be known to become interesting.

